

Engineering Record

A Weekly Journal Devoted to Civil Engineering and Contracting

PUBLISHED BY MCGRAW PUBLISHING COMPANY, INC.

Volume 70

NEW YORK, SATURDAY, NOVEMBER 21, 1914

Number 21

An Engineering Hall of Fame

WHEN Alfred Noble died last April there was a widespread sentiment among members of the engineering profession that his memory should be perpetuated by some suitable memorial. Two societies, the American Society of Civil Engineers and the American Institute of Consulting Engineers, appointed committees to consider the matter and report. The civil engineers are already committed to a program which involves a monument in Washington. The consulting engineers, however, as was noted in an editorial on page 689 of the June 20 issue of this journal, did not regard the suggestion for a monument with much favor. It is now apparent that the two organizations will select different forms of memorial, for the American Institute of Consulting Engineers at its meeting, Nov. 12, approved a plan for placing a bronze tablet to Alfred Noble in the United Engineering Societies Building in New York City. The essential feature of the proposal, however, is not merely that the Noble tablet be placed where many engineers may see it but that it shall form the nucleus of an engineering hall of fame, in which similar tablets to the memories of the most distinguished members of the engineering profession be erected.

The International Engineering Congress

THE five National engineering societies of this country have assumed responsibility, both financially and otherwise, for the success of the International Engineering Congress to be held in connection with the Panama-Pacific Exposition at San Francisco, Sept. 20 to 25, 1915. This success, obviously, will depend upon the support of American engineers and the committee of management should know at the earliest possible date what total membership of the Congress may be expected in order that it may make effective plans for the publication of its transactions. The technical papers to be presented will cover the general field of engineering and already 220 have been definitely promised or are well assured. Further details of the meeting are given in the Current News section this week. Engineers should cooperate in making the Congress a memorable one and should forward their applications for membership now so that the committee may work to the best advantage.

Concreting the Yale "Bowl"

THE distribution of plastic concrete by bottom dump cars or chutes is not new, but the use of two sets of chutes with cars delivering from the discharge end of one to the receiving end of the other is novel.

In the construction of the Yale "Bowl," described on page 556, the mixing plant for the facing of the inside slope had to be located outside of the embankment so as to permit the gridiron to be sodded as early as possible and to prevent the necessity of carrying aggregate to bins inside the bowl. A 90-ft. tower was required to lift the concrete to a height permitting it to be brought over the top of the embankment. As it was not desirable to use several mixing plants and as it would have been quite impossible to spout to every place on the facing from the plant used, the bowl being an ellipse 928 x 628 ft. in plan, the contractor decided to use two chutes, one from the tower to bottom dump-cars hauled by teams along the inside of the bowl and the other from hoppers to the forms. This method was used for the entire work, except for the part immediately in front of the tower, where the maximum uninterrupted length of spouting was about 250 ft. At all other points the distributing chutes were about 100 ft. long, while the length of the tower chute was about 150 ft.

Chicago's Package Freight Problem

AGAIN Chicago newspapers are giving space to the local freight terminal situation. Henry A. Goetz, consulting engineer, has expressed to the City Club his ideas on less than carload freight, suggesting that goods in this class be handled in substantially the same manner as full cars are transferred at Clearing. Walter L. Fisher, former Secretary of the Interior, stated recently before the National Industrial Traffic League that a co-operative freight terminal scheme would save thirty-two railroads millions of dollars each year. Both men emphasized the saving to shippers and railroads alike, should co-operative service be rendered and pointed out the necessity for reducing street congestion caused by the hauling of freight. The engineer estimated that 5000 tons of less-than-carload-lot freight are transferred in Chicago each day, and of this amount 1740 tons are hauled from one station to another by 2000 teams. It was suggested that all of this transfer work should be done at co-operative terminals outside the congested district. Purchase and utilization of the Illinois tunnel by the city was one means proposed by Mr. Goetz to extend such a system, but, like Mr. Fisher's scheme, he suggests universal freight stations covering different zones, so that a manufacturer would haul all of his product to one station only, loading it on cars which would then be dispatched to one central clearing district where full cars would be made up. From the operating standpoint, Mr. Fisher

stated, instead of every railroad undertaking to handle its own business and maintain separate freight terminals in the manufacturing districts, they should all be joined in one operating company, thus making a monetary saving and relieving street congestion. While the railroad passenger terminal problem was very noisily threshed out in Chicago a year ago, the freight problem is far from intricate and of vastly more economic importance, and therefore should receive plenty of attention by the public, which must ultimately bear the expense of inadequate, high-priced, inefficient, time-consuming service.

Art Standards for Lincoln Highway

THE officials of the Lincoln Highway Association and the American Institute of Architects are to be congratulated as a result of the alliance formed between the two organizations, whereby a committee of architects will act in an advisory capacity to the highway builders. It is hoped by this cooperation to obtain a uniformly intelligent architectural treatment of all the bridges, markers, stations and monuments which are to define the great thoroughfare and at the same time prove a means for a nation-wide lesson in good taste. Without cost to the highway association preliminary designs by the best architects of the country will be submitted, and provision will be made for further cooperation with all authorities having control of construction of sections of the proposed Lincoln Highway. The willingness of the architects to advise on a large civic enterprise like the Lincoln Highway is typical of the tendency of scientific men of today. Engineers and contractors coming in touch with officials and others interested in backing the many local enterprises that are engaged in building the highway should exert their utmost influence in getting them to work in harmony with the architects in selecting designs. It is time, also, that the State highway commissions paid more attention to the design of culvert headwalls and small-span bridges. Many a landscape or stretch of road is spoiled from the artistic standpoint by two upended blank slabs on which the form marks are still visible.

Experiences with the Panama Locks

IN view of the practical completion of the Panama Canal it was to have been expected that the annual report for the year ended June 30, 1914, of Governor George W. Goethals would differ somewhat from its predecessors. In the latest document, printed in abstract on page 559, more space is given to operation and less to construction than in previous reports. Especially is this the case with the lock gates.

The filling and emptying of the lock chambers developed certain facts which had not been anticipated. At Pedro Miguel the water level in the space between the upper sets of mitering gates is regulated by an auxiliary culvert and it has been observed that when water from the narrow forebay is admitted to the lock chamber, the level in this forebay falls faster than that in the space between the gates, producing a reverse head and causing the gates to open at the miter. As the hydrostatic head is the same in both places, being determined by the difference in water levels upstream and inside the lock chamber and not by the location of the conduit, it is quite natural that the retardation of the flow from the space between the gates is due to friction losses in the auxiliary conduit. This means that if the gates in the culvert are partly closed while those in the conduit are fully open this phenomenon will disappear. In the space between the lower gates it has been noticed that the water level has a tendency to rise more quickly than in the lock chamber. As this space is connected with the culvert through a T this tendency has been eliminated simply by closing the lower valves. As the culvert is large and the friction losses much smaller than was anticipated, the impact against the lower closed end of the culvert causes a rise in pressure at that point, thus giving the T-branch a greater discharge than any of the distributing branches in the floor of the lock chamber. This same impact phenomenon has also been observed in the lock chamber itself, where, as stated on page 561, it results in a more rapidly rising water level at the end of the distributors farthest from the culvert. As will be remembered from the design of these locks that part is the dead end of the distributors. Another observation that also indicates that this condition is due to impact is that when the culverts on both sides of the chamber are used the phenomenon disappears.

Necessity First in Municipal Improvements

WHEN curtailment of municipal improvements becomes a necessity in many cities and small towns because of the impossibility of increasing the debt limit, a decision must be made as to what improvement should have the first call on funds. Each administration must place a value upon the relative claims of different enterprises. Public opinion made by the newspapers quite largely determines the people's vote on such questions. Chicago has recently voted for three improvements of convenience—the \$7,000,000 Michigan Boulevard link to do away with the Rush Street bridge, the most congested trafficway in the world; \$2,000,000 for county roads; and money to acquire a forest preserve to encircle the city. Few engineers doubt the expediency of all of these improvements, but it is not clear why they should be chosen in preference to the filtration of the water supply, improved transportation facilities to prevent the almost unbearable insanitary

crowding on many of the principal routes of travel, adequate sewers, market houses and other promoters of health and sanitation.

Relative value of improvements in the small town was discussed recently by W. H. Dittoe, chief engineer of the Ohio State Board of Health. He classified them under three heads—public health and sanitation, safety and convenience, and education and social betterment. As examples of inconsistencies, he noted that one village had erected a monument to a citizen at a cost sufficient to install a much-needed water supply. Again in a town of 2000, with a seriously polluted supply capable of being improved at a cost of \$25,000, an indebtedness of \$50,000 was incurred for a school building of modern design and expensive construction to replace an existing building still in good condition. Another village with a population of 3000, embarrassed by the absence of a sewerage system, has found means to erect a city hall of such size and appointments as would serve 25,000 people. It is no uncommon thing to hear small town officials boast of a Great White Way lighting system and a casual observation, even at night, often discloses alleys reeking with garbage and refuse for want of a regular collection system. Unnecessarily wide pavements, the cost of which almost confiscates abutting property, often occur in the same town. Mr. Dittoe concludes that no city should undertake any other municipal activity until a public water supply of adequate quantity and good quality has been provided. Sewers should come next and then should follow other factors for the promotion of sanitation, safety and convenience, education and social betterment.

To return to the original question as to the preferential decisions in particular cases, there is a chance here for engineering societies to thresh out in their meetings the next best thing to do and thus be of material service to the communities in which they exist.

Engineering Positions as Legal Tender for Political Debts

IT is about time to stop the practice of using executive positions on public utility commissions or other State boards where engineering experience is necessary or desirable as legal tender for the payment of political debts. While lawyers and business men should be represented in these bodies it is deplorable that those professions only should be drawn upon to the exclusion of the engineer. In New York City, for example, the Public Service Commission, which is building the greatest system of subways in the world involving problems not only of law, finance and economics but also of engineering, has no member with engineering training. It is contended that under such conditions a board which controls engineering works and has no engineer member is not properly balanced.

There is nothing new about this plea. The only trouble is that the majority of engineers have been content to deprecate the present state of affairs and let it go at

that. But there will be a chance next spring to depart from the program of destructive criticism and do some constructive work. This opportunity has been seen clearly by the American Institute of Consulting Engineers, which has done a surprisingly large amount of useful work during the comparatively short period of its existence.

Next April a State constitutional convention will be held at Albany. The meeting, as may readily be inferred from its name, is called for the purpose of considering the State constitution and recommending to the electors such changes in it as the experience of two decades has proved necessary. The delegates have already been chosen—three from each Senate district and fifteen at large. Under the law the constitutional convention occurs only once every twenty years. It is evident, therefore, that if engineers do not make the most of their present opportunity it will be a long time before they will have another. The opportunity, briefly, is this: Secure amendments to the constitution that will require that the executive heads of engineering departments be engineers and that the engineering profession be adequately represented on the public utilities commissions of the State. As it is now, the appointing power chooses whom he pleases; he selects some very good men—and some very bad ones. Under the new plan he would be compelled to select men with specific qualifications for specific positions.

At its meeting on Nov. 13 the American Institute of Consulting Engineers discussed methods for carrying this plan into effect, and while no final method of procedure was adopted the work has been well started. It is reasonable to expect that comparatively few of the convention delegates have an adequate conception of the engineer's work. It will be necessary, therefore, to lay the cause of the engineer before them in such a way that they can appreciate why technically trained men are needed as department heads and commissioners. This will be accomplished in all probability by correspondence and by personal interviews. The Institute is fortunate in having in its membership many broad-gage men who can secure a respectful audience from those delegates whose co-operation must be secured and whose influence will count. The Institute's past efforts to influence Mayor Mitchel of New York City and former Governor Sulzer in properly recognizing the engineering profession in their appointments are well known. The same efforts will be made in the case of Governor-elect Charles S. Whitman, who will be urged to appoint engineers to State offices which can best be filled by technically trained men. The arguments have been carefully prepared and are in a form which, with only slight revision, makes them available for use in the present campaign.

The time to start on this pruning of the political plum orchard is now. Every engineer and every engineering society in the State should support the American Institute of Consulting Engineers in its present movement. It is only by united efforts

that the profession will make its influence felt at the coming convention. The plan is one which, if it succeeds, will mark a new epoch in the engineering history of New York State.

The Road Congress—Its Present Scope and Its Future

ACCLAIMED by those in attendance as the most successful of highway meetings, the fourth American Road Congress at Atlanta came to a conclusion last Saturday morning. If size be taken as the criterion, the success of the meeting cannot be disputed, for the registration broke all records, either here or abroad. Even without counting those present on Georgia Day, which drew largely from highway commissions in that and neighboring states, there was a registration of over 3000. Moreover, save for members of committees and distinguished citizens, Atlantans were not registered.

If a different standard be assumed, the comparison of this with other highway meetings will depend much upon the judgment of him who sets the standard. It was not, primarily, a meeting for and of technical men, but, both by design and accident, was suited rather to educate those not already expert in highway matters than to give information to commissioners, engineers and contractors already thoroughly grounded in highway fundamentals.

Three general types of papers may be recognized: Those of an elementary but fundamental character; those of a general nature, but requiring for their preparation long experience and thorough study of highway practice; and, finally, papers of a high order of technical excellence. The number presented in each class ranked in the order of enumeration. The elementary fundamental papers, while of little interest to experienced engineers, were exactly of the type best suited to the majority of the audience—men either of comparatively little experience in highway work, or trained solely along practical lines without understanding the underlying principles.

To one expecting a highly technical meeting, the congress was probably a disappointment. Nevertheless, it is fulfilling admirably the purpose for which it was organized—to spread the gospel of good roads—and, while so doing, disseminate ideas regarding the fundamentals, not only of construction and design, but also of legislation, financing and administration. It may well be questioned, however, whether a change in program is not advisable, to the extent of devoting a number of sessions to the engineering problems connected with the design, construction and maintenance of the higher types of road. These sessions should be organized on the "round-table" plan and should be devoted to a discussion of details rather than of general characteristics of hard-surfaced roads. A leader should be designated to present a summary of practice regarding the particular subjects selected for discussion, this summary furnishing the text for the con-

ference to follow. Such subjects as experiences with different types of shoulders, the methods of transporting and handling the aggregate for foundation work and concrete roads, and experiences with various types of bituminous construction might well be so treated.

It may be argued that the highway engineers in attendance, between sessions, when examining the exhibits, at luncheon and dinner, do discuss just these phases of their work and that such conferences are unnecessary. While there is much discussion at odd times, it reaches comparatively few of those in attendance. Those who have participated in round-table conferences will be sure to indorse the suggestion, and if the officers of the congress have any doubts as to its merits they have only to write to a dozen highway engineers for their opinions. Moreover, the same plan—that of querying engineers—might be pursued in determining the particular topics for these conferences.

There is a tendency, in the opinion of this journal, for the congress to become entirely a medium for elementary and general education in highway matters. While this should be its primary function, and the chief reason for its existence, its hold on the highway field will be much strengthened if the meetings are made the occasion for the exchange of the very latest experience in roadway work. At present that phase is in danger of disappearing into the background, and some new idea or new plan must be introduced to hold the attention and secure the support of the technical expert.

In saying this there is no desire to belittle the accomplishments of the congress. It was a tremendous undertaking, carried to a distinguished success, and any account of it would be incomplete which did not give to the executive secretary, I. S. Pennybacker, and the business manager, Charles P. Light, the credit which they deserve. Having by their preliminary work insured a large attendance, an excellent exhibit and good hall accommodations, they remained at their posts continuously throughout the congress, at instant command to straighten out difficulties, to bring people together and to facilitate in every way the conduct of the meeting.

Bacteriological Standard for Drinking Water on Common Carriers

THE vexed question of what constitutes a pure drinking water has been treated by the United States Government in an interesting way in a recent order issued by the Secretary of the Treasury. According to a letter of promulgation issued by him to the Surgeon General of the Public Health Service, Oct. 12, 1914, common carriers in the future will be required to supply water for passengers in interstate traffic which conforms to a bacteriological standard set by a commission appointed for the purpose Jan. 22, 1913. The first progress report of this commission together with the bacteriological standard adopted has recently been made public.

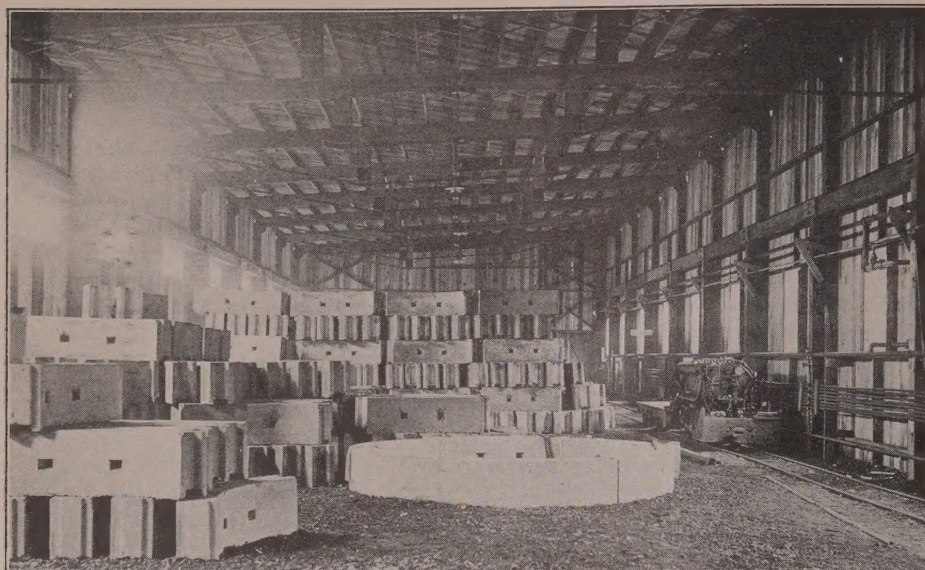
It is evident that the commission, which is composed of some of the best known sanitary experts of the country, has studied the subject in a very careful manner and has reached a conservative conclusion. This is shown by the emphasis placed upon the nature of the standard recommended. The tests employed are not to be regarded as standards of purity—that is, something to be lived up to—but standards of maximum departure from purity, or limits of permissible bacteriological impurity. They are in fact arbitrary rules for the exclusion from use of waters which fail to conform to them. They relate to the waters served on railway trains, steamboats and other means of communication devoted to interstate traffic and are not intended to apply to public water supplies generally. It will be surprising, however, if sanitary engineers do not use them as a measurement of the shortcomings of public water supplies.

The requirement that the number of bacteria in the water shall not exceed 100 per cubic centimeter when determined by the 37-deg. agar count might appear to filter attendants as unnecessarily liberal, but it must be remembered that the waters used by common carriers are obtained from various sources, and are stored in all sorts of containers for indefinite lengths of time. Moreover, the allowable bacterial content is a maximum figure, the exceeding of which would cause the water to be rejected.

The test for *B. coli* is more strict and this, in fact, will probably become the chief item of the standard. The allowance of gas production in one out of five 10-cu. cm. portions of water is approximately equivalent to about two *B. coli* per 100 cu. cm. or 0.02 *B. coli* per cubic centimeter. This standard can be met by the ordinary output of filter plants and by unpolluted ground waters. In view of the importance of protecting the public health against fecal contamination and remembering that drinking waters alone are involved, this standard does not appear to be too strict.

In setting the standard the commission found it necessary to consider the matter from three points of view—the protection of the public health, the expense to the company of providing water which will comply with the standard, and the labor and time required on the part of the U. S. Public Health Service to make the necessary tests. The standard set seems to be as satisfactory as it is possible to obtain at the present time. That it is not perfect or necessarily final is implied by the commission's report.

Although more than a year was devoted to the consideration of the subject of chemical and physical standards the commission has not thus far been able to devise satisfactory regulations. This is due to the great diversity of the water supplies of the country with respect to their mineral contents and to the present lack of adequate scientific knowledge as to the physiological effect of small quantities of mineral salts commonly found dissolved in water. It is to be hoped that the commission will not cease its labors but will devote renewed attention to this unsolved problem.



CONCRETE BLOCKS IN STORAGE HOUSE, WITH ONE RING IN POSITION

West Side Tunnel Extension at Cleveland

Three Miles of 10-Foot Tunnel Driven by a Special Excavator and Lined with Huge Concrete Blocks Set by a Hydraulic Erector

CONCRETE blocks of cyclopean dimensions set in rings back of a tunneling machine comprise the lining for the 16,000 ft. of 10-ft. tunnel now well started at Cleveland to extend the West Side intake into Lake Erie beyond existing crib 4, which is 1 1/3 mi. from shore. The extension is 100 ft. below the water level and 50 ft. below the ground surface. It will draw water well beyond the zone of continuous pollution. From the present crib two tunnels of 5 and 7-ft. diameters respectively supplied the old West Side station until 1904, when the use of this crib was discontinued on account of the bad quality of the water so near shore.

Three times bids were received and rejected on the extension and finally the city

determined to carry out the work by day labor. The crib over the future inlet was floated into place and sunk into position two years ago, so that work will be prosecuted from two headings. In October the shaft in this outer crib was sunk and the eye of the tunnel was about to be started, while at the inside crib 320 ft. of tunnel lined with four rings of brick had been constructed. In this length is included a chamber 16 ft. in diameter in which the shield was erected. Later on the chamber will be converted into an air lock. Operations are being carried on from shaft 2 on the 7-ft. tunnel on Whiskey Island, 7000 ft. from crib 3. On this island are located the power plant, shops, block plant and engineers' headquarters. Equipment above

ground has been in running order for some time and future progress at the rate of 1 ft. per hour at each heading is anticipated.

CLAY TUNNELING MACHINES

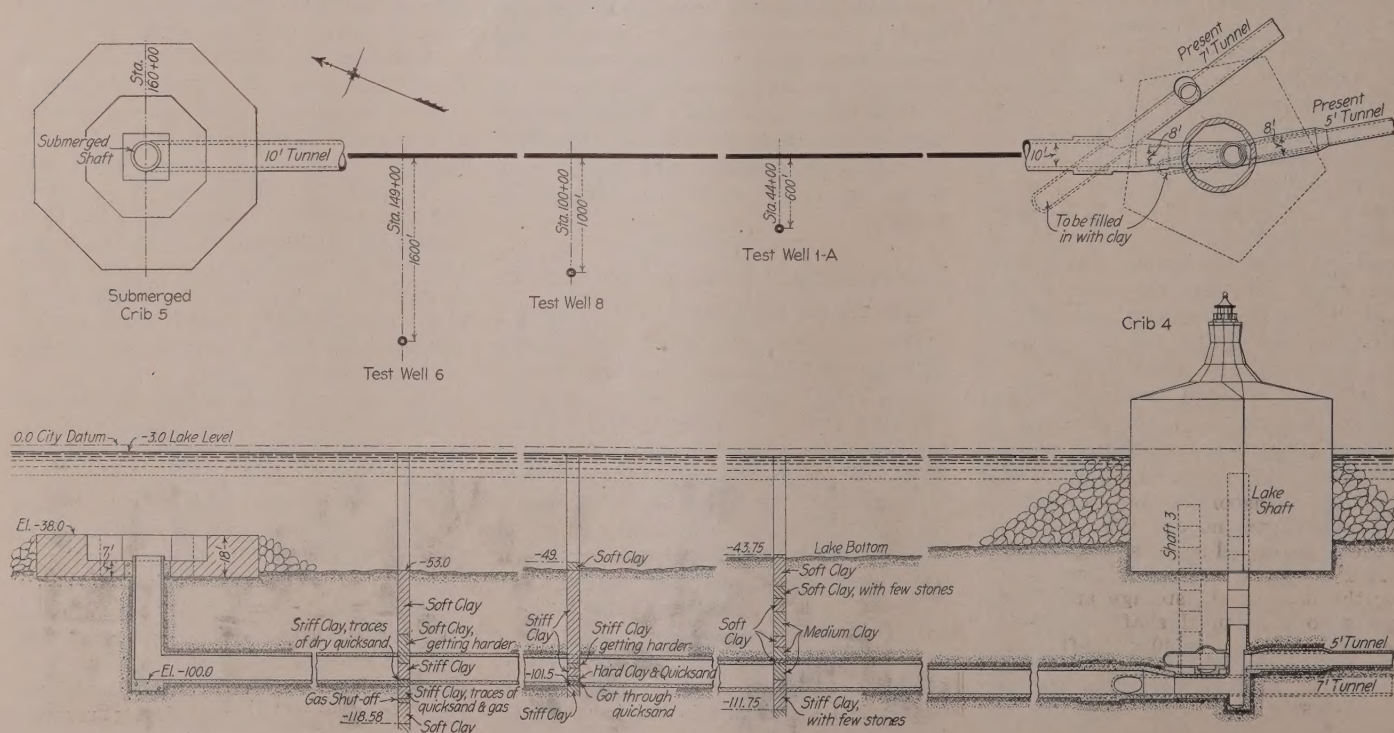
The material which the tunnel will pierce is almost uniformly a stiff clay of such a consistency that air will probably be unnecessary, although a small amount will always be used to insure safety. On account of the nature of the clay it was decided to use the tunneling machines designed and patented by Charles J. Carpenter and L. W. Anderson of Grand Rapids, Mich., this type having been tried out in sewer work at Detroit.

The machine is carried in a regulation steel shield over the ring of hydraulic jacks and consists of a motor-driven central shaft carrying a centering boring knife which is driven ahead as a guide; a sleeve shaft which carries on a cross arm a tool cutting a spiral 6 x 6-in. ribbon from the face of the tunnel, and two apron conveyors which transport the billets of clay, into which the ribbon breaks up, back under the erecting machine to industrial cars which will carry the material to the shafts. The billets are placed on the conveyor by men at the face; otherwise no handling is required. The cross arm consists of a main stationary arm and another raked arm to which the cutting tool is attached.

Thirty 1-yd. cars have been provided at each heading and for transportation there are two Porter compressed-air locomotives operated under 1200-lb. pressure. They have a rated hauling capacity of ten cars loaded with 3000 lb. each up a 1-per cent grade. Additional cars will be provided.

BLOCK ERECTOR

An essential part of the work, designed in the engineering department of the division of water, is the concrete-block erector, which consists of a mounted steel frame or erector carriage carrying a pivoted hydraulic ram with grappling tongs on one end and a counterbalance on the other. In addition to the radial motion given by the



PLAN AND PROFILE OF CLEVELAND INTAKE EXTENSION—LOCATION AND CHARACTER OF TEST BORINGS

ram and the rotation given by a 5-hp Dake air motor, the ram is so mounted on I-beam tracks that it can be moved along the center line of the tunnel with respect to the carriage. At the rear of the frame and mounted on the same I-beam tracks is a trolley hoist for removing the blocks from the cars and placing them in a central position under the hydraulic erector, which has a throw of 28 in. and is operated under 125-lb. pressure.

In setting up the circle of blocks the fourth and fifth blocks will be wedged away from the erector carriage while a temporary wooden top piece is placed. The shield will then be forced forward about 1½ ft., dragging the erector carriage after it. The wooden block will then be replaced by a concrete block, the erector moving in a horizontal backward direction. The 4 x 4-in. concrete keys are then inserted at each end of the top block, the two ¾-in. reinforcing bands placed in the recesses left in the faces of the blocks and all joints grouted. The blocks are manufactured by the city under the Parmley patent.

The shield shell is 15 ft. long, made up of three 7/16-in. plates ending in an 18-in. cast-steel cutting edge. It overlaps two of the concrete blocks and the twelve jacks find their bearing against the face of the last ring through about 1½ ft. of blocking. The jacks were obtained second hand from the Contractors' Clearing House Association, of Pittsburgh, and were made for 5000 lb. pressure, although it is expected that 2000 lb. or less will, as a rule, be sufficient. They are each capable of exerting 140 tons pressure on the shield, equivalent to a skin friction of 5800 lb. per square foot over the cylindrical surface. At the start, when the shield had been standing, 600 tons pressure was required to start movement. After that only 360 tons pressure was needed, this being applied through eight jacks.

TELPHER SYSTEM IN BLOCK PLANT

Pouring of the blocks has been under way for some time, as it is desired to place no blocks that are less than thirty days old. A comprehensive factory and a storage building, connected by a covered industrial track and trolley hoist line, will allow work to proceed without interruption, regardless of weather conditions. The factory is a one-story 73 x 100-ft. frame building located at the foot of a 27-ft. railroad embankment over which the aggregates are delivered to the storage bins as shown in the drawing herewith. There are seven bays under the sawtooth roof, in six of which blocks will be cast. A ½-yd. Smith mixer and other equipment are located in the other bay.

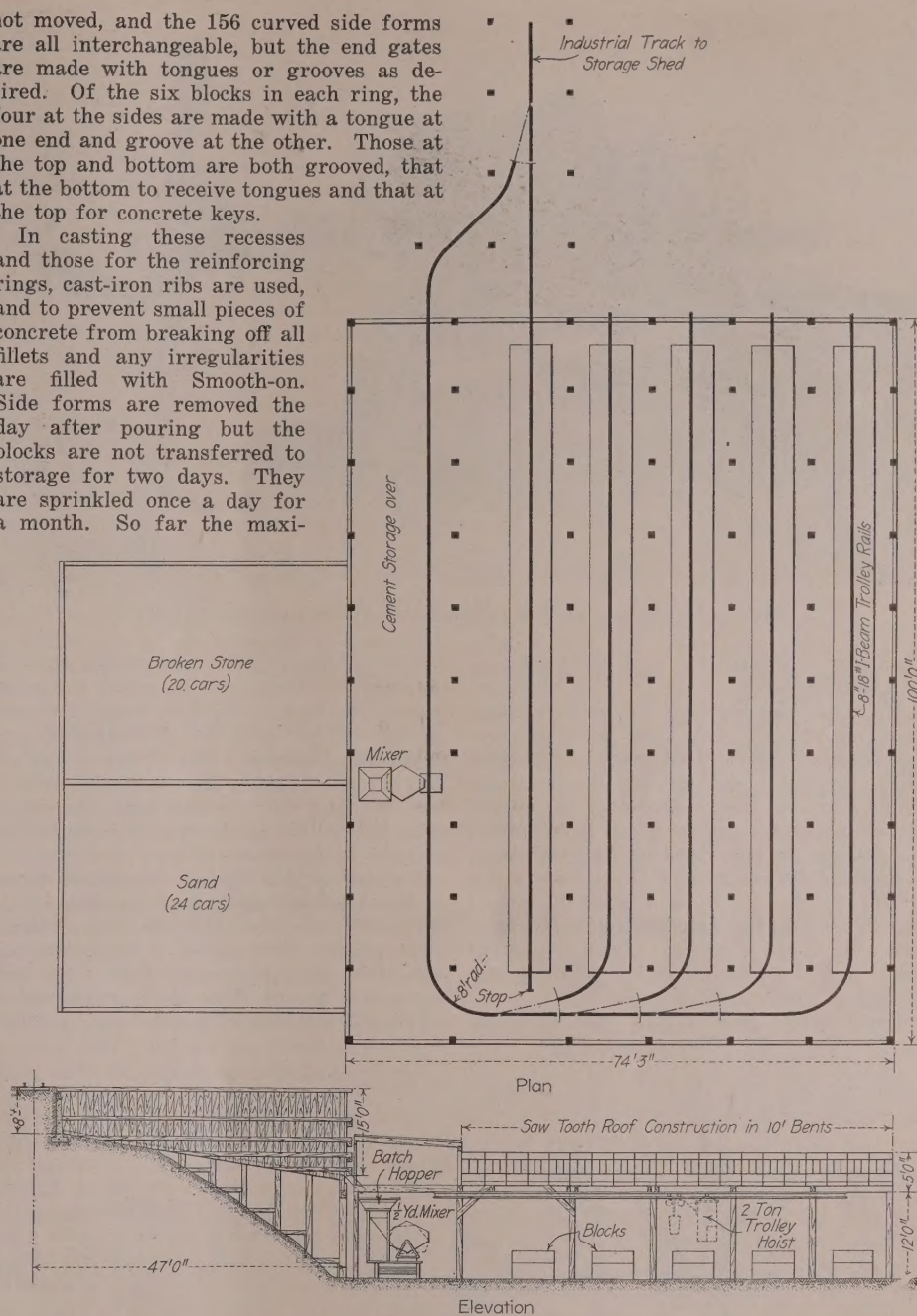
The 2-ton Brownhoist trolley hoist runs on a telpherage system of 8-in. I-beams suspended in each of the bays. It is used to transport the concrete in a ½-yd. Insley bucket, to remove the steel forms, after a day's time, to an empty set of cast-iron pallets and to transport the blocks to storage or load them on industrial flat cars, by which they are carried to the storage building. A Porter compressed-air locomotive handles the flat cars to storage and from that point to the tunnel shaft. A 1-ton hand crane is used in the 40 x 100-ft. storage building to stack the blocks.

CASTING THE BLOCKS

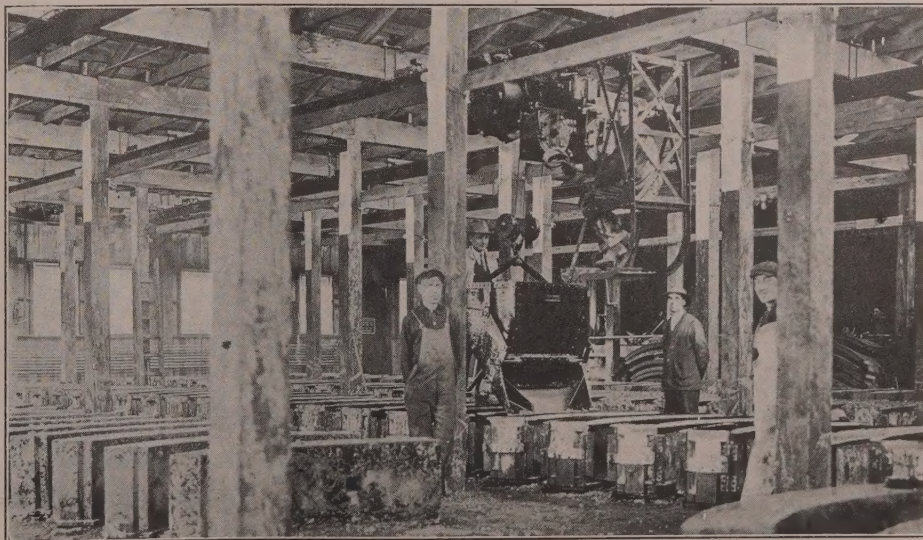
Space is available for thirty-six pallets, which are set on 2½-ft. centers. They are

not moved, and the 156 curved side forms are all interchangeable, but the end gates are made with tongues or grooves as desired. Of the six blocks in each ring, the four at the sides are made with a tongue at one end and groove at the other. Those at the top and bottom are both grooved, that at the bottom to receive tongues and that at the top for concrete keys.

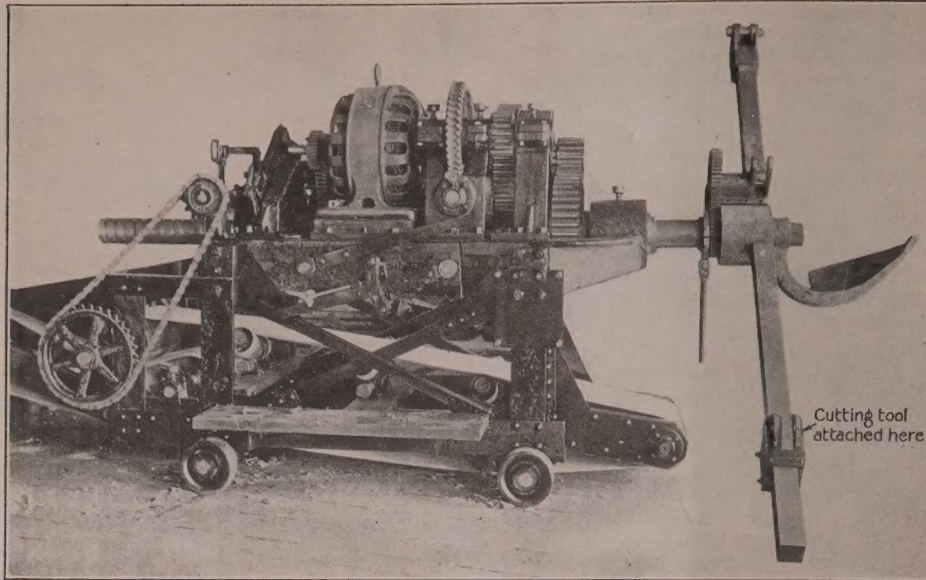
In casting these recesses and those for the reinforcing rings, cast-iron ribs are used, and to prevent small pieces of concrete from breaking off all fillets and any irregularities are filled with Smooth-on. Side forms are removed the day after pouring but the blocks are not transferred to storage for two days. They are sprinkled once a day for a month. So far the maxi-



GENERAL ARRANGEMENT OF AGGREGATE BINS, MIXER AND TELPHER SYSTEM IN PLANT BUILT FOR CASTING BLOCKS FOR LINING TUNNEL



TELPHER HANDLING CONCRETE IN CLEVELAND BLOCK-CASTING PLANT



SPECIAL SPIRAL EXCAVATOR DEVISED FOR TUNNEL WORK IN CLAY

mum rate of casting has been 114 blocks in an eight-hour day.

Material unloaded from the bottom-dump cars falls into the bins. As the bins have not enough slope to feed directly into the mixer hopper a second-hand double-drum steam hoist has been rigged over the mixer roof to operate a slip scraper. A retriever rope makes the operation not unlike that of a slackline drag scraper.

Thus far the mixtures used have been 1 part Universal Portland cement to 2 parts sand to 4 parts broken stone. As the blocks are 11 x 18 in. in cross-section, their weight is nearly 1200 lb.

Some experimenting has been done in

setting up the rings and in placing the $\frac{3}{4}$ -in. round reinforcing rings, which are more than 32 ft. long. Different kinds of couplings have been used, but a turnbuckle has finally been adopted. Except for $4\frac{1}{2}$ ft. of tangent at the top in the outer ring, bringing it nearly into contact with the inner ring, the centers of the rods are spaced $1\frac{7}{8}$ and $8\frac{3}{8}$ in. from the inside of the block.

For driving the shaft hoist motors, those at the heading and those to supply light, current is obtained from the city electric-light plant. Three boilers are provided, one for heating purposes and the other two for operating the three air compressors, a Laidlaw-Dunn-Gordon duplex and a Rand

for low pressure and a three-stage Laidlaw-Dunn-Gordon for the 1200 lb. required to operate the locomotives.

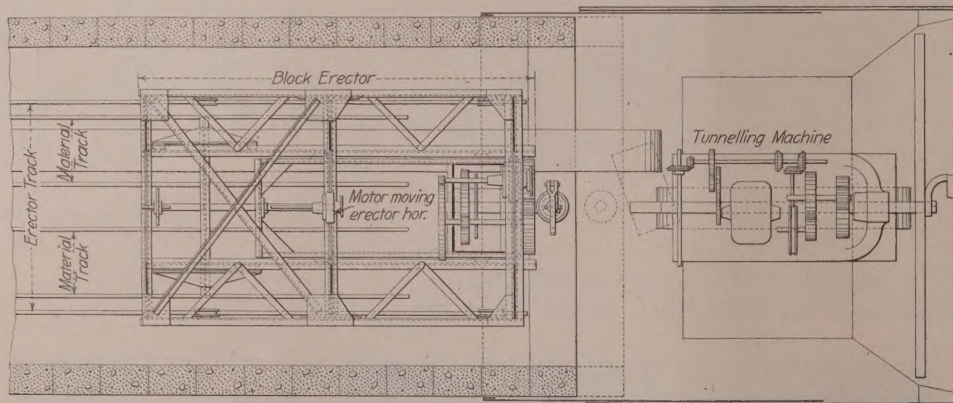
On crib 4 there are two motor-driven hydraulic pumps with an accumulator for furnishing the water pressure to operate the hydraulic jacks. The pumps are designed to work against a maximum pressure of 5000 lb. per square inch. On the same crib is an air compressor for furnishing air at 125 lb. per square inch to the air motors on the erector and also for use with the grouting machines.

C. F. Schulz is commissioner of water for the city of Cleveland, reporting to the director of public utilities, C. W. Stage. G. C. Van Duzen is superintendent of the tunnel construction and W. F. Whitehead of the block factory. C. P. Jaeger is engineer of construction and S. E. Roof is designing engineer.

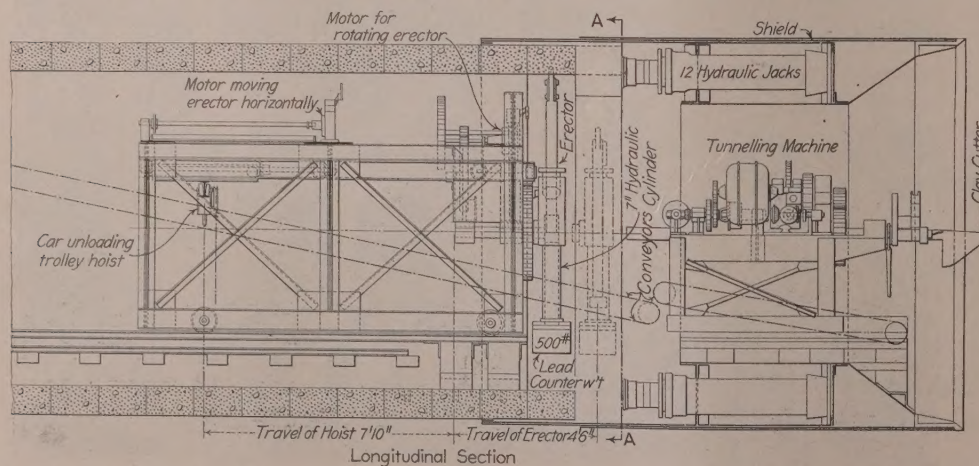
Draining Irrigated Land

DRAINING irrigated land twenty years under cultivation is being carried out on the Pioneer Irrigation District by the U. S. Reclamation Service. F. T. Crowe, engineer in charge, reports in the "Reclamation Record" that on July 1, the work of draining 34,000 acres at a cost of \$350,000 was one-third done. Two electrically driven dragline excavators equipped with $1\frac{1}{4}$ -yd. buckets had excavated 568,000 cu. yd. at a cost of 9 cents per yard. This figure includes labor, supplies, power, engineering, general and administrative expense, and assumes that the excavators will be scrapped when the work is done. The crew consists of one operator at \$5 per day, one oiler at \$3.25 and one laborer at \$2.50.

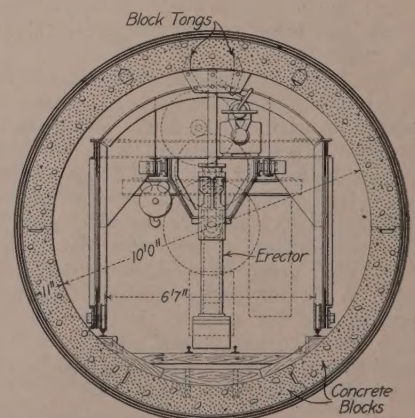
Active competition is maintained between the individual operators on each machine and between the combined operators on the different machines. At the end of each shift the operator stakes the ditch completed by him during the shift, each operator having different colored stakes. By this method the construction engineer on his daily inspection can check up the quality of the work accomplished by each operator during the day, and each operator can size up the amounts and classes of work accomplished by his fellow operators. At the end of each month an operators' efficiency report is compiled. This is studied carefully by each operator and tends to put life and interest into the work.



Sectional Plan



Longitudinal Section



Section A-A

DETAILS OF TUNNEL MACHINE AND BLOCK ERECTOR, SHOWING WORKING ARRANGEMENT OF OUTFIT

Lessons of the East Boston Sewerage Plant Explosion

Report of Investigation of Accident at Screen Room of Pumping Station of Metropolitan Water and Sewerage Board Places Blame on Gasoline Vapor

AN exhaustive investigation of a disastrous explosion in the screen room of the East Boston (Mass.) pumping station of the Metropolitan Water and Sewerage Board has been concluded in the finding of Special Justice Charles J. Brown of the Municipal Court, East Boston District, following an inquest in this important case. The explosion occurred shortly before 10:30 a. m. on June 1, 1914, causing the deaths of six men and seriously injuring three others. In his finding Justice Brown concludes that gasoline vapor was the explosive agent, and recommends that all garages and other establishments using gasoline in the municipalities having connections with the pumping station be compelled to install separating traps as is now required under the regulations of the City of Boston.

GASOLINE SEPARATORS REQUIRED

A general laxity was found on the part of local authorities in preventing the discharge of gasoline, naphtha and benzine into sewers. Since the handing down of this finding, John A. O'Keefe, fire hazard commissioner of Boston, metropolitan district, has drafted a set of garage rules superseding the rules of the district police, and containing a provision that all public garages and all private garages housing more than three cars must be equipped with a device for separating gasoline or other volatile inflammable oils from the water and other waste entering the sewers. These rules have not yet been promulgated, but are likely to become effective in the near future in view of the demonstrated dangers of permitting the discharge of gasoline into sewers.

All the sewage of the north metropolitan district with the exception of Winthrop passes through the East Boston pumping station. The trunk sewers of the district have a combined length of 62.5 mi. in varying sizes, the largest being 9 ft. in diameter. With these are connected about 720 mi. of local sewers under the control of seventeen municipalities, the total number of connections from dwellings, manufacturing plants, public buildings, etc., which are tributary to the north metropolitan system being about 78,000. All the pumping stations on the system are operated continuously through the 24 hours of every day in the year. The system was placed in operation in 1895.

CHARACTER OF SEWAGE

The sewage from this district is discharged into tide waters off Deer Island, an average of 56,000,000 gal. per 24 hr. being discharged in 1913. This consisted of ground-water, manufacturing wastes, household sewage and street washings in some parts of the district. At the different stations this sewage is conducted through screens to remove rags, paper and other solid material which might interfere with the operation of the pumps. The material collected at the screens is, as a rule, pressed and consumed in the boiler furnaces. A large amount of oil passes through the sewers, the principal supply of which is the oil used for sprinkling

streets, which is a heavy oil and which probably does not give off explosive gases at the temperatures of the sewers. A large amount of household grease also passes.

At times strong evidence of the presence of gasoline is found in the sewers. The use of gasoline for household purposes has largely increased of late and generally there is no other convenient method of disposing of it after use than through the sewer connection. Laundries and cleansing establishments are another source of supply, but perhaps the largest amount comes from garages where gasoline is frequently used for cutting oil and cleaning parts of automobile machinery. The rubber shoe plants situated in Malden use large quantities of benzine for cutting rubber and various leather establishments, tanneries, etc., in the district contribute their quota. All these sources are intermittent, and efforts on the part of the board to trace gasoline to its source generally prove unsatisfactory. After the gasoline runs a few miles in the sewers it becomes dissipated and gradually disappears.

CHANGES IN SCREENING APPARATUS

Chapter 461 of the Acts of 1912 directed that the board should make changes in the screening apparatus at the East Boston pumping station. The screening had been conducted in an underground chamber, badly ventilated, and it was proposed to have the work done from the level of the ground floor; also that a duplicate set of screens and a by-pass should be constructed. This work had been partially completed and was being resumed after the expiration of the flood period of the present year (January to June), when the explosion occurred. Up to the stoppage of work last winter the presence of gasoline was at times noted, but the condition was such that the men worked constantly without difficulty. A system of natural draft ventilation had been installed and this had been ample to take care of the vapors. In attempting to resume work on June 1, it was found that the air in the lower part of the sewer chambers was so bad that it was impossible for men to remain there any length of time. To guard against trouble ropes were passed around each man who went down so that he could be withdrawn if overcome by gases.

It was attempted to improve the air by washing down the walls with a hose and an electric hanging lamp was lowered. Only one man at a time was engaged in this work, and no other work was being done at the time in the sewer. The explosion occurred in the old screen room and the building was wrecked. The odor of gasoline was strong on the morning of the disaster. It is not known what ignited the explosive gas. At the point where the sewer entered the screen room it was 9 ft. in diameter, the screen room being about 18 ft. square at a depth of 30 ft. below the surface of the ground. About the screen room was a building of brick and concrete about 30 ft. square and 20 ft. high, which was destroyed by the explosion wave, which continued on through the engine room wrecking machinery, windows and doors, passing out through skylights and carrying everything before it.

EXAMINATION OF SEWAGE SAMPLES

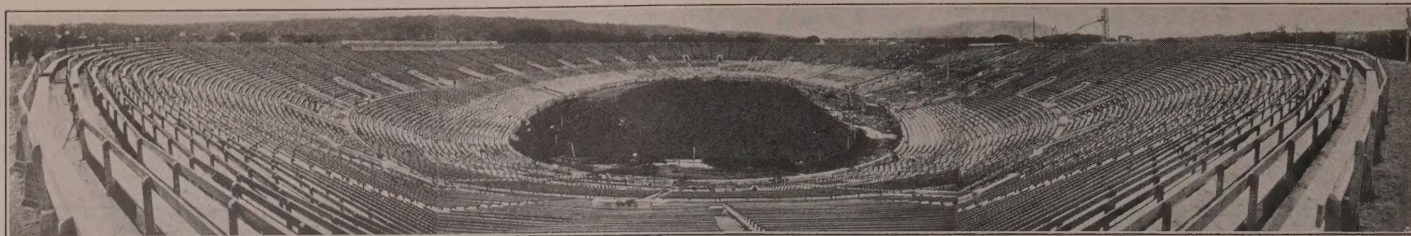
A day or two after the explosion, H. W. Clark, chief chemist of the Massachusetts

Board of Health, Boston, made an examination of the sewers in East Boston with the object of determining the cause of the disaster. Eighteen samples of air and gas from different manholes of the metropolitan sewer were taken within ten days. All had a strong odor of gasoline and six were strongly explosive when tested in the laboratory. One or two samples were collected which did not explode on account of an excess amount of gasoline vapor, but when these were diluted with air explosion took place. Experiments were also made in the laboratory in regard to the volume of gasoline which would cause enough vapor in the large volume of air to become explosive. It was found that 0.5 c.c. of gasoline when allowed to vaporize and when filled with 2 gal. of air, formed a very violent explosive mixture. Mr. Clark also made some examinations of the sewage, but found no evidence of gasoline in it; but the air on every visit was always found to be filled with a mixture of gasoline when taken from manholes. He reported in conclusion that the investigation and general testimony in regard to the prevalence of gasoline odors in the East Boston sewers near the pumping station and by numerous odor tests at various manholes indicated that the explosion at the station was caused by a dangerous mixture of gasoline vapor and air.

Walter L. Wedger, chemist on explosives and inflammables of the Massachusetts District Police; Frederick D. Smith, engineer in charge of works, Metropolitan Water and Sewerage Board, and Edgar S. Dorr, engineer, sewer division, Public Works Department, Boston, Mass., all agreed in extended testimony that gasoline vapor was the primary cause of the explosion. John Campbell, of the special service bureau of the Edison Electric Illuminating Company, of Boston, Mass., who visited the scene of the explosion an hour and a half after it occurred, and who has investigated gasoline explosions in a number of other cities, also concurred. Since the reconstruction work was again taken up in the screen room a forced system of ventilation has been installed with successful results.

Paved Streets in Denver

PAVED streets in Denver, involving a total measurement of 162,266,090 sq. yd., were kept clean for the period from June 1 to Dec. 31, 1913, at a cost of 7 cents per square yard, according to the annual report of the Board of Public Works. In addition to the ordinary cleaning and sweeping, the streets in the central paved district, embracing 14,976 city blocks or 37,440,000 sq. yd. of pavement, were regularly washed during four months of the year. During the summer season the sidewalks used most were washed at a cost of 26 cents per block for each washing. An aggregate of 4320 unpaved alleys were cleaned. From them 9370 cu. yd. of rubbish were removed and hauled to the dump, at an average cost of 59½ cents per cubic yard. A ton of rubbish was removed daily from 386 rubbish cans at an expense of \$7.50 per day. About 60,388 cu. yd. of snow were removed and hauled to the dump at a cost of 29 cents per yard. The most difficult problem encountered in this work was the removal of ice and snow from many of the alleys, in which it was as high as 20 ft. deep, having been deposited there from the roofs of abutting buildings.



PANORAMIC VIEW OF INTERIOR OF YALE "BOWL", TAKEN FROM ONE END SHORTLY BEFORE ITS COMPLETION

Yale "Bowl" Construction Finished in Time for Harvard Game To-Day

Drag-Line Excavators Removed About 130,000 Cubic Yards of Earth—Concrete for Lining Slopes Supporting Seats Was Distributed by a 90-Foot Tower

WITH the Harvard and Yale football teams lined up against each other in their annual struggle, the Yale "Bowl", the immense concrete stadium which seats 61,000 spectators, will be formally opened to-day. In spite of its large capacity there has not been sufficient room to accommodate all the applicants for seats, and about 7500 extra seats have been added on the promenade on top of the embankment. Even then several thousands of applications could not be filled, as about one week before the game they numbered more than 80,000. The construction program was planned with the express object of having the huge amphitheater finished in time for the great gridiron battle, and work involving 300,000 cu. yd. of earth excavation, 175,000 cu. yd. of embankment, and 25,000 cu. yd. of concrete has been completed ahead of schedule.

The design of the bowl, which is in the form of a 930 x 750-ft. ellipse inclosing a field 500 x 300 ft. in plan, was the subject of an article in the Engineering Record of March 28, page 369. Since that time, however, slight modifications have been made in certain details of the plans. Two designs for the seat tiers were originally proposed, one contemplating solid reinforced-concrete steps and the other a reinforced-concrete slope to which wooden steps were to be anchored. The first of these plans was adopted. The seats shown in a drawing in the previous article were made of wood and anchored to the steps. They were placed so that the feet of the spectators rested on the same step which supported the seat. This detail has been changed and the seats are now supported on the next higher step. The seat itself has been redesigned and consists of a low galvanized iron standard anchored to the concrete as shown in the drawing on page 558.

Inside the retaining wall at the base of the seat tiers the drainage system has also been slightly modified. The former article indicated a concrete gutter with a 6-in. drain midway between stairs leading down to the field. The drainage from the seat tiers flowed over the field wall into this gutter. The new design has a covered collecting gutter on top of the field wall which, for architectural reasons, has been provided with a parapet, thus making the former method of drainage impossible. The low points of this gutter lie at the top of the field stairs and the water is discharged by 6-in. drains. On the ground, in front of this drain, is a small collecting basin from which the water is conveyed into the sewer.

EXCAVATION

A large part of the construction consisted in excavating about 175,000 cu. yd. for the bottom of the bowl and the lower twenty-nine rows of seats. This material was deposited in the embankment forming the support for the upper thirty-one rows of steps. The top stratum of the ground, 22 in. thick, consisted of black and yellow loam and was used for surfacing the field, the outer slope of the embankment and the grass plots outside the bowl. The contractor used two Thew $\frac{5}{8}$ -yd. steam shovels and two dragline excavators for the excavation of the bowl.

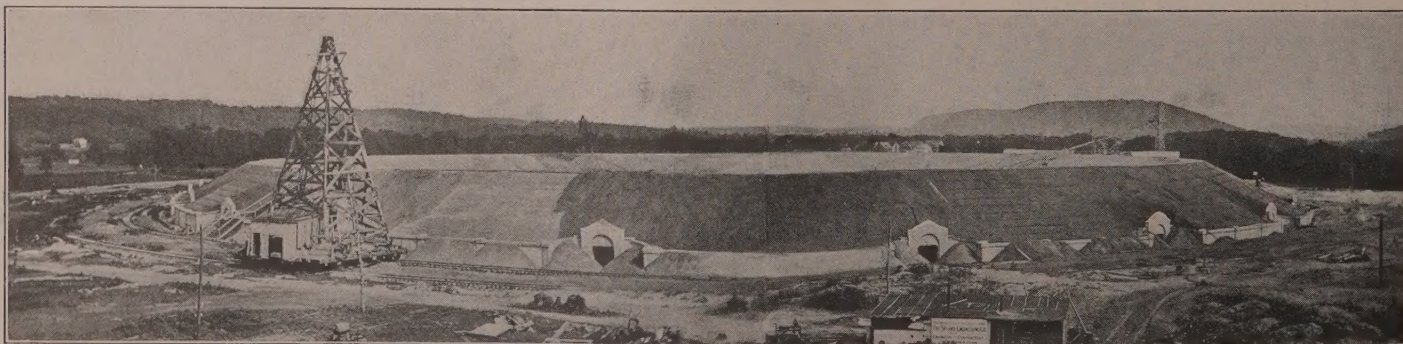
Before the excavating bucket was designed the contractor made a trip to study similar plants and find a bucket that would be suitable. Part of the excavation was 27½ ft. below the surface of the ground and the bucket had to lift the material over the slope of the bank and deposit it at the top of the embankment—a total lift of 54 ft. As a result of this trip the contractor concluded that such buckets

must be designed for each particular job and that they must fill the following requirements: (1) When lowered the digging teeth must be at an angle most suitable for the material to be excavated; (2) the buckets should fill in the shortest possible length of haul; (3) when filled the center of gravity of the load should be in such a place that the bucket would stop digging; (4) when coming up the bucket should not dig, and this condition must be fulfilled without any extra vertical lift; (5) the weight of the bucket must be in proportion to the weight of material to be excavated. Three experimental types of bucket were built at a cost of more than \$3,000 before a suitable one was obtained. The one selected had a net capacity of 2 cu. yd. and its weight, empty, was 4500 lb.

DRAGLINE OUTFITS

Two dragline outfits were used and the cables were anchored at one end to deadmen and at the other to wooden towers 85 ft. high running on a double elliptical track outside the bowl. The horizontal pull at the top of one of these towers was 120,000 lb. and a counterweight of about 125 tons was, therefore, required at the base of each tower in addition to the weight of the machinery. The base of the tower was 50 ft. square, its front posts were 8 x 10 in., its rear posts 8 x 8 in. and its cross braces 3 x 12 in. To transmit the tension on the rear of the tower to the base 1¼ in. bridled tension rods were used.

The mounting of the wheels under the tower was a difficult problem, as the track was elliptical and had four rails, two at the front and two at the rear of the base. Pivoted trucks were considered, but as the benefit of the rear wheels as counterweights would then have been lost, this scheme was abandoned. Finally twenty



EXTERIOR VIEW OF BOWL AFTER EMBANKMENT HAD BEEN FINISHED, SHOWING TOWERS FOR DRAGLINE EXCAVATION

wheels were mounted on ten axles of which five were placed in the front and five in the rear. All axles were located on the average radius for the elliptical track and mounted on 12 x 12-in. timbers so fastened that they were flexible. In addition each axle was given an ample amount of play so that it could slide radially. This scheme worked well.

Each dragline was operated by a two-cylinder, double-drum link-motion, Lambert cableway engine with 12 x 16-in. cylinders. The steam was supplied by a 125-hp locomotive boiler. This machinery was placed as near as possible to the rear of the tower in order to utilize its weight to the best advantage, the operations of the engineer being directed by a signalman. This system proved more satisfactory than when the engineer himself watched the bucket and operated it without signals. When no signalman was used the engineer often made an error in judgment and pulled off the $\frac{7}{8}$ -in. plow steel cable.

The maximum excavation was 3000 cu. yd. per day of twenty-four hours, and the average daily excavation was 400 cu. yd. (The contractor had based his bid on an average excavation of 450 cu. yd.) The maximum distance from tower to dead-man was 750 ft. and the maximum excavation for this distance was 1500 cu. yd. per twenty-four hours. The maximum monthly amount of excavation was 44,400 cu. yd. during the month of May.

Part of the excavation was made with steam shovels, the material being loaded on horse-drawn wagons. A portable hoisting engine placed on top of the embankment helped the horses to pull the load to the top of the fill.

EMBANKMENT AND PLAYING FIELD

On top of the embankment the material was distributed in 6-in. layers by horse-drawn scrapers. These layers were rolled eight times by a grooved roller followed by a smooth roller. During rolling, the embankment was sprinkled, and after the rolling of one layer was finished water was turned on night and day, including Sundays, so as to solidify it. Each roller was drawn by four horses. The specified weight was 800 lb. per linear foot of roller.



PART OF FINISHED CONCRETE LINING, WITH SEAT STANDARDS IN PLACE



TOWER, CABLEWAY AND SPECIALLY DESIGNED DRAGLINE BUCKET

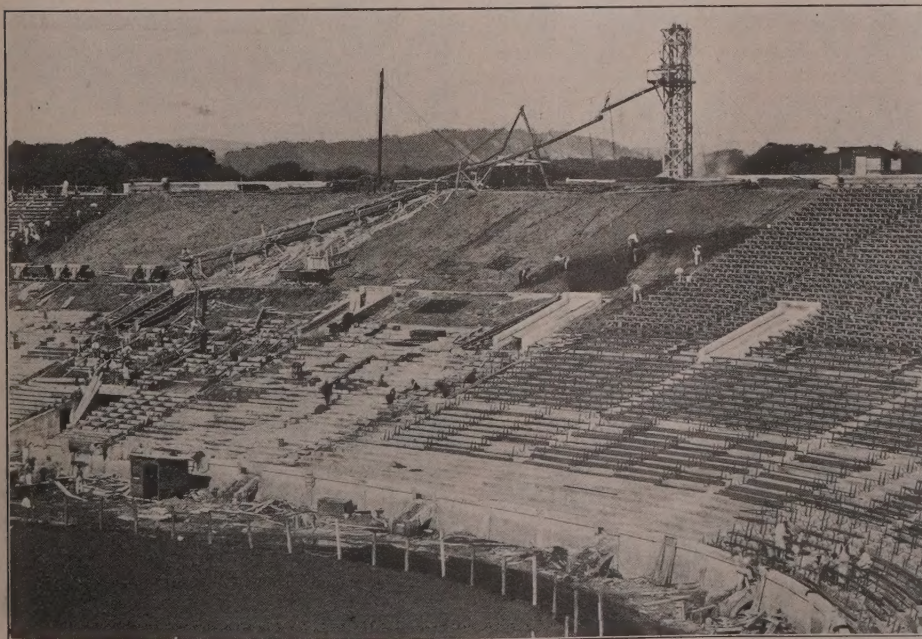
As each roller was about 5 ft. wide its weight was approximately 2 tons. The water for sprinkling was obtained from a well 20 ft. deep sunk for the purpose, and the necessary pressure was furnished by an electrically driven triple-cylinder pump. As soon as the embankment was finished its outer slope was turfed in horizontal strips 8 ft. apart, and seeded between strips. The horizontal strips prevented hard rains from scouring the slope.

The natural material under the playing field is all sand and gravel, so that no extra provision for drainage was required. Efforts had to be made instead to keep the gridiron from becoming too dry. The field was excavated about 19 in. below its finished grade and two 8-in. layers of black loam from the stripping of the ground were deposited and rolled with a 5-ton steam roller. On top of this was placed a 1-in. course of humus from Lexington, Mass., harrowed from 3 to 4 in. into the loam. This humus absorbs moisture to the extent of about 14 per cent of its weight. Upon the humus was placed a 2-in. layer of turf. On top of this was sprinkled a thin course (hardly $\frac{1}{8}$ in. thick) of black loam, screened and free from lumps, in which grass seeds were sowed.

CONCRETE WORK

Three separate concrete mixing plants were erected. For conveying and placing concrete different methods were adopted at each of these plants. When the outer retaining wall was built a plant was placed on a high trestle straddling the wall. The mixing was done in one $\frac{3}{4}$ -yd. Smith and one $\frac{1}{2}$ -yd. Chicago cube mixer and the concrete was delivered by 1-yd. Lakewood bottom-discharge cars which ran on top of the forms. The aggregate bins were not located above the mixers; chutes deposited stone and sand in measuring cars carrying the batch to the mixers.

For the concrete work on the entrance and exit tunnels (which were built in the open and later covered by the embankments) a plant with a 1-yd. Marsh-Capron mixer, located inside the bowl, was used. From the plant tracks were laid to each tunnel up an incline to the top of forms and along the top. To the bases of these inclines the Lakewood cars were drawn by



TOWER, CHUTES AND CARS PLACING CONCRETE IN LINING OF BOWL

teams, a portable hoisting engine pulling them up the incline and along the tops of the forms.

When the construction had proceeded far enough to permit the placing of the field wall and the concrete lining of the bowl—that is, when the excavation and the placing of the embankment were completed—this latter plant was moved outside the stadium and located at the main entrance. It was then provided with a 90-ft. wooden tower with a 1-yd. self-dumping hoisting bucket, operated by a two-drum Lidgerwood hoisting engine. From the hopper at the top of this tower concrete was spouted 150 ft. in Insley chutes to 1-yd. Lakewood bottom-discharge cars running on a track placed on the fill slightly above the inside tunnel portals. Eight cars, drawn in pairs by horses, were used. As the cars had a capacity of 1 cu. yd. and the batch mixed also was 1 cu. yd. no hopper was necessary at the end of the chute. When a car had been placed at the end of the chute the button of an electric bell was pressed, giving the tower man the signal to open the hopper. Another bell, operated by the mixer man, gave the signal to the engineer to hoist the bucket.

Horses pulled the cars along the embankment to points where distributing chutes were located. For the portion directly in front of the tower no cars were used, the tower chute discharging directly into the distributing chute. The maximum distance spouted in this manner was 250 ft.

The mixture used was 1:2:4. The sand was obtained from the excavation and the rock from the Farnam quarry in Westville, Conn. It was a hard, blue trap rock, crushed to sizes which passed a 1-in. screen, and conveyed to the work in one 5-ton and one 4-ton Packard motor truck and deposited directly in the mixer bins. The sand was deposited in its bins by small cars hauled up inclines by the hoisting engine which operated the concrete tower.

LINING THE BOWL

No concrete lining was placed on the filled part of the bowl, as the embankment is likely to settle in spite of the wetting and rolling. The fill was made to allow for a shrinkage of 6 in.; if the shrinkage is less the surplus will be scraped off.

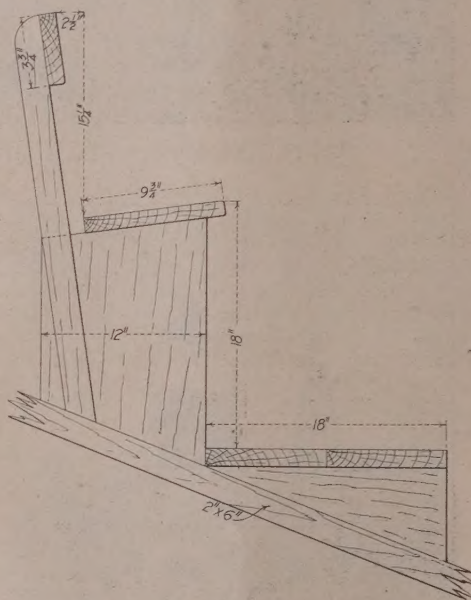
The lining of the excavated part of the bowl was built in checkerboard fashion, three steps to a block, from 10 to 16 ft. wide. These blocks are separated by a single layer of tarred felt. At one radial joint in each section between tunnels a $\frac{3}{8}$ -in. Elastite paving joint has been provided for expansion. Each block has been heavily reinforced by Havermyer bars and is figured to carry a live load of 100 lb. per square foot uniformly distributed. Several assumptions as to how the earth would support the slabs were made: (1) Slab supported at two opposite sides; (2) slab supported at the center and acting as a cantilever; (3) slab supported on all four sides; (4) slab supported at its four corners, etc. The slabs have been dimensioned for the greatest stresses thus obtained.

In order to break up the monotony of the concrete surfaces the steps and inside tunnel portals have been given a dark grey color, while the field wall and the stairs to the playing field have the natural concrete color. The coloring was obtained by a plaster consisting of 1 part cement, 2 parts sand, and 1 lb. of lampblack per barrel of cement. To make the bond between

this plaster and the concrete as strong as possible the mortar was put on the inside of the forms for the risers and the concrete deposited before this layer had set. Immediately after the form was filled the treads were finished with the same mixture.

WATERPROOFING

All tunnels have been waterproofed on the outside. On the sides the waterproofing consists of one coat of coal-tar pitch. The tops have three layers of tar paper and one layer of Tartex pasted together with pitch; on top is a 1-in. course of 1:2 cement mortar. That this method of waterproofing is efficient has been shown, for no leakage could be discovered, although the hydrostatic head in one place was about 6 ft. This particular case oc-



DETAILS OF TEMPORARY AND PERMANENT SEATS IN THE YALE "BOWL"

curred at the main entrance, where two spectator tunnels go through the gate house. Between the finished walls of the gate house and tunnels pockets 8 ft. deep have been formed. Shortly after heavy rains it was noted that water stood about 6 ft. deep in one of these pockets, but observations disclosed no leakage within the tunnel.

SEATS

The seats and back rests are made of Douglas fir from Portland, Ore., painted with two coats of China oil, one applied after the seats are in place. Galvanized iron standards, varying in height from 6 to 8 in., so that the height of seat is always 18 in. above the foot rest, and anchored to the concrete by bronze U-bolts, support the wooden parts of the seats.

In erecting the seats the standards were first placed and leveled up before the woodwork was fastened to them, after which they were grouted. The grout consisted of cement and sand and contained so much water that it could be poured from a can. The standards were leveled up by wooden wedges and a tinker's dam of putty or clay was used to hold the grout.

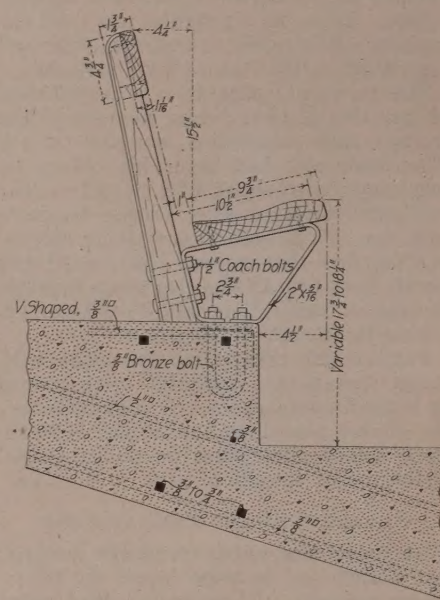
Temporary wooden steps and seats have been erected on the fill, and at the top of the embankment in front of the gate house at the players' tunnel a press stand with 250 seats has been provided.

From 115 to 269 men, averaging 200,

have been employed by the contractor. Four inspectors were employed—one for the permanent seats, one for the concrete, one for the field work and one for the concrete mixing.

PERSONNEL

The designer of the Yale bowl and the engineer in charge of its construction is Charles A. Ferry, consulting engineer, of New Haven. It is being built for the Yale Committee of Twenty-One, Inc., of which Hon. T. DeWitt Cuyler is chairman and David Daggett, secretary. E. G. Williams acted as advisory engineer and Donn Barber as consulting architect to the committee of which Thomas C. Atwood was construction manager and Joseph H. Mulvey, chief inspector. The seating structure and playing field have been under the personal



supervision of Everard Thompson, assistant secretary of the committee.

The Sperry Engineering Company, Inc., of New Haven, was awarded the general contract on a unit basis. A. William Sperry is president of this company and George H. McLean, treasurer, acted as general superintendent of construction. The New England Engineering Company had the subcontract for the electric wiring of the tunnels and Day & Lee applied the waterproofing.

THE SMALLER HYDROELECTRIC PLANTS IN UTAH are being closed down. It is stated that sixteen out of the twenty-four of such plants will be closed and that the remaining eight will be able to supply the entire market now served by the twenty-four. This does not mean that the electric light and power service will be impaired, but is in pursuance of the policy of retrenchment by the owners, the Utah Power & Light Company, a subsidiary of the Electric Bond & Share Company, of New York, which has taken over the smaller plants built by independent companies. Each of them had a surplus of power and when the amalgamation was perfected there was a surplus of power. For the present more than \$500,000 invested in these power plants will be kept idle until the market has so developed as to require the additional power obtainable from these plants.



VIEW FROM TOP OF CERRO LUISA OF SHIP ENTERING EAST CHAMBER OF PEDRO MIGUEL LOCKS, AUGUST 15, 1914

The Year's Work on the Panama Canal

Abstract of Annual Report of Governor George W. Goethals, Covering Construction, Operation and Maintenance for Fiscal Year Ended June 30, 1914

WITH the blowing up of the Gamboa dike on Oct. 10, 1913, and the dynamiting of a passage through the Cucuracha slide two days later dry excavation for the Panama Canal was practically finished. All of the principal structures of the canal were completed during the period covered by the annual report for the year ended June 30, 1914, of Governor George W. Goethals. This document has just been made public and an abstract of it follows:

ORGANIZATION

The organization which existed at the close of the previous fiscal year and was described in the last annual report underwent a number of changes during the year, as the construction work was reduced and concentration of what remained seemed desirable and advantageous.

All municipal engineering work in the Canal Zone formerly performed by the construction divisions, as well as that performed in the cities of Colon and Panama by the division of public works, department of civil administration, was consolidated, effective July 16, 1913, forming the division of municipal engineering, under George M. Wells, resident engineer, reporting to the chief engineer. For the design of the buildings for the new town of Balboa, an architectural force was organized on the Isthmus. With the admission of water into Culebra cut by the blowing up of Gamboa dike on Oct. 10, 1913, the central division was abolished.

Effective April 1, 1914, by Executive order and in conformity with the Panama Canal act of Aug. 24, 1912, the existing organization was abolished and the one contemplated by the act was made effective. Under this organization there were created a department of operation and maintenance, a purchasing department, a supply depart-

ment, an accounting department, a health department, an executive office, and a Washington office of the Panama Canal.

Col. H. F. Hodges, U. S. Army, was designated as engineer of maintenance; H. H. Rousseau, U. S. Navy, as engineer of terminal construction, and Capt. Hugh Rodman, U. S. Navy, as superintendent of transportation.

The scope of the work of the Washington office remained about the same as previously reported, Major F. C. Boggs, U. S. Army, being continued in charge as general purchasing officer and chief of office.

By Executive order of May 20, 1914, a committee of six members was created to arrange and provide suitable ceremonies for the formal and official opening of the Panama Canal, as is provided for in section 4 of the Panama Canal act. The committee is composed of persons who were members of the Isthmian Canal Commission and is to be known and referred to as the committee for the formal and official opening of the Panama Canal.

The central division, embracing the same work as described in the annual report for 1913, continued in charge of Lieut.-Col. D. D. Gaillard, U. S. Army, as division engineer, until the division was abolished on Oct. 15, 1913. During his absence on regular annual leave and during part of his illness, the work was conducted by A. S. Zinn, resident engineer, as acting division engineer. Subsequent to the abolition of the division and until Jan. 1, 1914, Mr. Zinn continued in charge of steam-shovel work which was undertaken to lighten the banks, of the approaches to the pontoon bridge, and of the Naos Island breakwater. Colonel Gaillard died, as the result of a tumor on the brain, Dec. 5, 1913.

The Atlantic division, embracing the same construction work as described in the

last annual report, continued in charge of Lieut.-Col. William L. Sibert, U. S. Army, as division engineer, until Feb. 1, 1914, when the division was abolished. He continued on duty as a member of the Isthmian Canal Commission until April 1, 1914.

The fifth division, chief engineer's office, continued in charge of H. O. Cole as resident engineer, and had charge of masonry construction of the Pacific locks, dams, and spillway, the operation of the Ancon quarry, and excavation of the channel between Pedro Miguel and Miraflores Locks until Oct. 15, 1913, when the locks were transferred to the first division, and he continued in charge of the balance of the work until Jan. 31, 1914, when the amount of the work remaining necessitated a reorganization and he severed his connection with the canal.

LOCKS AND DAMS

Gatun Locks.—As noted in the last annual report, the concrete work of the locks assigned to the Atlantic division was finished June 14, 1913, with the exception of the lamp-post bases, bases for snubbing buttons and mooring posts, stairway parapets, and the closing of openings left for construction purposes. The amount of all concrete laid in the Gatun locks, exclusive of that used in the construction of the control house, from the beginning of the work to the close of the fiscal year, aggregated 2,067,731 cu. yd. at an average division cost of \$7.2122 per cubic yard. The backfilling of the side walls, made of material obtained from borrow pits, was continued until Dec. 19, 1913, when the status of available money necessitated discontinuing further work. The amount placed during the year was 91,576 cu. yd. at a division cost of \$1.4304 per cubic yard. The total amount of material used for backfill up to June 30, 1914, aggre-

gated 2,119,406 cu. yd. placed behind the side-walls at a division cost of \$0.5007 per cubic yard, and a total of 113,163 cu. yd. placed in the center wall at a division cost of \$0.7692 per cubic yard. The construction of the control house, begun in April, 1913, was completed by the close of the fiscal year, with the exception of the door and window frames.

Gatun Spillway.—Work on the spillway consisted of completing the fill of the openings of the valves in the body of the dam, raising the piers to full height, setting the valves, and completing the bridge. So far as the spillway proper is concerned, the structure was finally finished in October, 1913. During the year 7,047 cu. yd. of concrete were laid, at an average cost of \$8.9005 per cubic yard, making the total amount of concrete placed in the structure 231,179 cu. yd., at an average cost of \$7.5273 per cubic yard.

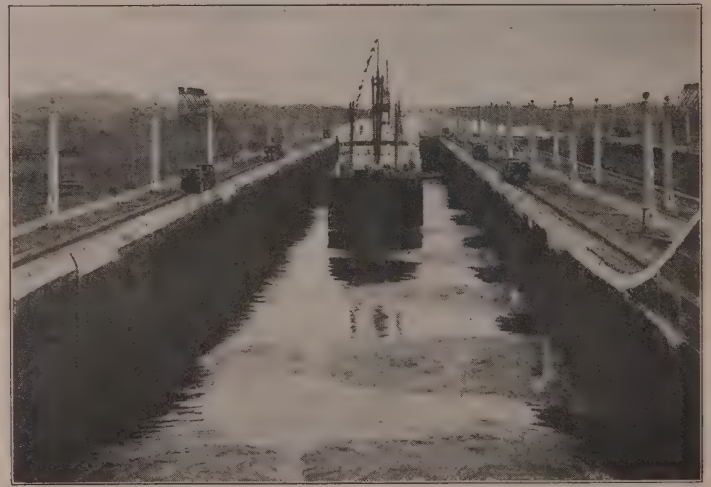
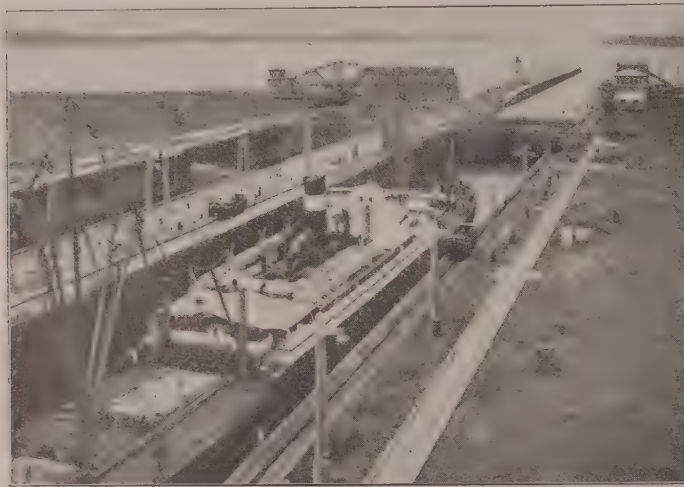
Gatun Dam.—Work on the dam consisted in placing material on the portions east and west of the spillway to bring the dam to

Pedro Miguel Locks.—Masonry construction carried on at these locks by the fifth division consisted of lamp-post bases, bases for snubbing buttons and posts, stairway wells, and the control house. The total amount of concrete laid at the Pedro Miguel locks, exclusive of that used in the construction of the control house, from the beginning of the work to the close of the fiscal year, was 928,326 cu. yd.; and the division cost was \$5.6575 per cubic yard. The backfilling of the side-walls was completed in March, 1914, and the filling of the center wall in February, 1914. During the fiscal year 27,750 cu. yd. of material were placed behind the side-walls, at a division cost of \$1.1146 per cubic yard, and 5619 cu. yd. in the center wall, at a division cost of \$1.6139 per cubic yard. The total amount of material used for back fill up to June 30, 1914, aggregated 834,288 cu. yd. placed behind the side-walls, at a division cost of \$0.4131 per cubic yard and 220,768 cu. yd. placed in the center wall, at a division cost of \$0.4777 per cubic yard.

the present fiscal year the total amount of concrete laid in the spillway was 10,112 cu. yd., of which 9,570 cu. yd. were plain concrete at a division cost of \$8.3510 per cubic yard, and 542 cu. yd. were reinforced concrete at a division cost of \$11.8730 per cubic yard. The total amount of concrete laid in the spillway to June 30, 1914, was 74,254 cu. yd. at a division cost of \$6.2160 per cubic yard. The last concrete was laid in February, 1914. Dry filling on the west dam was completed in February, 1914. During the year 98,424 cu. yd. of material were placed in this dam at a division cost of \$0.6431 per cubic yard. The total amount of dry filling placed in the dam since the beginning of the work is 1,758,423 cu. yd., at a division cost of \$0.4582 per cubic yard.

LOCK GATES

The design, construction and inspection of the lock gates, chain fenders, emergency dams, operating machinery and electrical installations continued in charge of Col. H.



STEAMSHIP ANCON PASSING THROUGH GATUN UPPER LOCKS (AT LEFT) AND GATUN LOWER LOCKS (AT RIGHT)

full height, in bringing the slopes generally to final grade, completing the fill around and over the core wall connecting the dam with the locks, paving the upstream slope, and in laying such permanent tracks as it was deemed advisable to maintain in order to make quick repairs in case of necessity. For this purpose two steam shovels were at work until March, 1914, borrowing material from north of the dam, principally red clay, and in accomplishing the grading and completion of the fill; 314,160 cu. yd. were handled at a division cost of \$0.4033 per cubic yard. Paving the upstream slope, as outlined in the last annual report, was completed in August, 1913, and 9,860 cu. yd. of large riprap were used at a division cost of \$2.0403 per cubic yard in place. The total amount of large and crushed rock used for paving, therefore, was 94,330 cu. yd.; and the average division cost was \$1.4378 per cubic yard. Permanent tracks aggregating 5,780 ft. in length were laid with good rails and ties, with proper grades and curves. Observations for settlement were continued throughout the year. Seepage from the dam has been negligible. At the close of the rainy season two small streams were found issuing from the north toe in the west portion of the dam, but with the advance of the dry season these ceased entirely. There was no seepage of any kind apparent in the east portion of the dam.

Miraflores Locks.—At the close of the previous fiscal year the concrete of the locks proper was completed, except the lamp-post bases, bases for snubbing buttons and mooring posts, parapets around the stairways, and the nosing at the end of the south-approach pier. The amount of all concrete laid in the Miraflores locks, exclusive of that used in the construction of the control house, from the beginning of the work to the close of the fiscal year was 1,507,794 cu. yd. at a division cost of \$5.1695 per cubic yard.

The total amount of concrete laid in the Pacific locks, exclusive of that used in the construction of the control houses, at the close of the fiscal year aggregated 2,436,120 cu. yd. at an average division cost of \$5.3555 per cubic yard.

The backfilling of the side-walls was completed in May, 1914, and the filling of the center wall in March, 1914. During the fiscal year 360,198 cu. yd. of material were placed behind the side walls at a division cost of \$0.6021 per cubic yard, and 92,244 cu. yd. in the center wall at a division cost of \$0.5273 per cubic yard. The total amount of material used for back-fill up to June 30, 1914, was 2,366,252 cu. yd. placed behind the side-walls at a division cost of \$0.3855 per cubic yard, and 249,457 cu. yd. placed in the center wall at a division cost of \$0.5846 per cubic yard.

Miraflores Dam and Spillway.—During

F. Hodges, U. S. Army, as assistant chief engineer until April 1, 1914, and subsequently as engineer of maintenance.

The construction and erection of the lock gates under contract were continued and completed in accordance with the supplemental articles of agreement entered into Jan. 14, 1913. All the gates were completed within the time specified in the supplemental contract, the time at Miraflores being anticipated by about two months. The original contract provided that the contractor should paint the gates with two coats of red lead, at his expense, and with a third coat of some other pigment to be furnished by the Isthmian Canal Commission, applied to the gates at the contractor's cost. To provide for more complete protection, this agreement was modified and at Gatun arrangement was made for an additional coat, making two of red lead and two others, instead of one. These additional coats consisted, one of U. S. Navy anticorrosive and one of antifouling paint, and were applied to those parts of the gates in the lower locks which are constantly under water. On the remaining gates at Gatun two coats of equal parts of graphite and red lead were applied. It was intended that no red lead should be used at Pedro Miguel except for the upper guard gates, the protection to consist of three coats of damp-proof paint. At Miraflores the gates in the lower lock from El. —6 to the bottom were

to be given two coats of red lead, followed by one coat of anticorrosive and one coat of antifouling paint.

All the other gates were to be given three coats of a proprietary paint consisting of a hydrocarbon mixture. On account of delay in receipt of the damp-proof paints intended for use on the Pedro Miguel gates, some of these were painted with hydrocarbon paint from Miraflores and, conversely, a few of the Miraflores gates were painted with damp-proof paint. In all of these cases the third and fourth coats were applied by the commission forces.

Due to impurities in the water at Gatun Lake, none of the paints, except the bitumastic which was applied directly to the metal on small sections of several of the gates at Gatun, has proved satisfactory, and the paint on those parts which are constantly under water is in very poor condition. The action of the gates in service is entirely satisfactory, the leakage at the quoin and miter posts being extremely small. The cost of the gates complete was \$6,471,806.99, of which \$5,632,942.38 were paid under the contract, and the balance of \$838,864.41 was for inspection, painting, recess covers, fixed steel, special tracks and services furnished the contractor.

Towing Locomotives.—As noted in the last annual report, a contract was entered into with the General Electric Company for furnishing 40 towing locomotives of their design and manufacture, the first locomotive to be delivered by Jan. 15, 1914, and four locomotives each month thereafter. Twenty-one locomotives have been delivered and are in operation.

Remote Control.—The General Electric Company was awarded the contract for furnishing the lock-control switchboards for Gatun, Pedro Miguel and Miraflores locks. The detail design of the board was left entirely to the contractor, the work being subject to the approval of the commission's inspector in the United States. The switchboards are located on the second floor of the control houses and the interlocking racks on the mezzanine floor. The boards are designed to represent the locks in miniature, all machines being represented by individual control switches, and wherever it is important for the operator to know the exact position of the machines being controlled indicators are provided which operate in synchronism with the machines in the lock wall tunnels.

Hydroelectric Plant.—The erection of the hydroelectric station continued under the Atlantic division until Sept. 8, 1913, when the work was transferred to the building division of the quartermaster's department. With the exception of the doors and some of the carpenter work, the building was completed at the close of the fiscal year at a total division cost of \$328,457.08. The installation of the equipment was continued during the year and was turned over to the operating force on June 18, 1914, without tests, which were made subsequently, and after correction of some of the defects the plant took over the load from the Gatun steam plant on July 13, 1914. The amount expended on the installation of the machinery was \$300,355.60.

Emergency Dams.—The emergency dams at Gatun were completed before the close of the last fiscal year, but the final acceptance tests had not been finished. During the year the two dams at Gatun were accepted and the dams at Pedro Miguel and Miraflores were finished and accepted. A

test was made at Gatun in May, 1914; the dam was swung, girders and gates lowered, and the pipes driven to close the spaces between the ends of the gates. The upper lock was then filled with water to lake level, the upper guard gates and upper operating gates were opened, and the intermediate and lower gates of the lock closed. The upper lock was emptied through the culverts until the water level was below the guard-gate sill. This brought the full head of 472-3 ft. on the emergency dam, which was found to have a leakage of 950 sec.-ft. This leakage produced no dangerous current in the lock, and it would have been easy to close any of the lower gates in the face of the stream. Another purpose of the test was to determine whether the emergency dam could be used in lieu of a caisson for unwatering the locks so as to permit access to the gates for painting, but the leakage was too great to use the dam, as it at present stands, in lieu of the caisson. Experiments are being made to devise a means of stopping the flow. The total amount expended for the emergency dams was \$2,206,984.67, of which \$1,958,329.90 were covered by the contract for delivery of the material and its erection, and \$248,654.73 for inspection and other expenses assumed by the Panama Canal under the contract.

OPERATION OF LOCKS

The lockages made during the fiscal year gave an opportunity to try out the locks and their machinery. The first one at Gatun was made on Sept. 26, 1913, when the tug Gatun was put through the Gatun locks, followed on Oct. 14, 1913, when a part of the dredging equipment was locked through the Pacific locks to the lake level. From these dates throughout the year various craft belonging to the Panama canal were passed back and forth as the necessities of the work required, in addition to the tows that were instituted for handling freight from the Balboa terminals to Colon and Cristobal for the Panama Railroad Company. To try out the towing locomotives, the Panama Railroad steamers *Allianca* and *Ancon* were locked through Gatun locks and returned, and through the courtesy of the agent of W. R. Grace & Co. the *Santa Clara* was locked through the Pacific locks and returned.

The operation of the locks has developed certain facts in regard to the action of flowing water which had not been anticipated. As previously noted, the gates of the upper locks of each flight and of the Pedro Miguel locks are duplicated. The upper pair of gates is called the guard gates and the lower pair of the upper two the lock gates. At the lower end of the locks the upper pair of gates is called the safety gates and the lower pair of the two the lock gates. The space between the guard gates and the lock gates is regulated by an auxiliary culvert, while the space between the safety gates and the lower gates is regulated by a T-culvert. When the water in the upper lock is low and the valves are open there is a sudden drop of the water level in the forebay. This is more noticeable at Pedro Miguel, where the canal above the forebay is relatively narrow, than it is at Gatun and Miraflores, where the forebay opens immediately into the lake. This drop is faster than can be followed by the water in the space between the guard and upper gates, and the result is a reverse head on the guard gates, causing them to open at the miter. This lasts but a short time.

In the first lockages the T-culvert regulating the space between the lower and safety gates was in free communication with the side wall culvert near its lower end, but above the lower valves. When the upper valves were raised the water in the space between these gates rose faster than in the lock; consequently there was a reverse pressure on the safety gates, causing them to open at the miter, the pressure being sufficiently great to compress fully the springs in the gates-maneuvering struts. Due to the possible danger of crippling the moving apparatus by such reverse stress, the valves in the T-culvert were partially closed, choking the communication between the side-wall culvert and the space between the gates. By experimenting, a degree of closure was reached which caused the water in the space between the culverts to lag behind the water in the lock when filling, and at the same time to fall rather more rapidly when emptying. In this way a positive pressure was always kept against the safety gates. With the use of both side and center wall culverts, as the rapidity with which the water level in the lock changes is greatly increased, a different adjustment will be necessary.

When the valves in the side culvert are raised and the water enters the lock the flow of water is greater through those openings in the laterals which are nearest the middle wall than through those nearer the side culvert. As the water rises in greatest volume next to the middle wall, there results a slight slope of the surface toward the side wall. When both side and middle culverts are used no such action is noticeable. The first gush of water from the side culverts appears to come from the highest laterals and then successively from the others. So far as can be ascertained, however, it can not be stated that the discharge is greatest from any one of the laterals.

OVERTRAVEL OF WATER

In filling or emptying a small canal lock the water levels approach each other with a rapidity depending upon the square root of the diminishing head. Toward the end of the operation the change in level becomes slower, and the flow of water is supposed to cease either just before or at the equalization of the levels. Frequently the gates are opened with a very slight head against them to avoid the loss of time involved in waiting for the head to vanish entirely. In filling or emptying the locks of the Panama Canal there is a noticeable overtravel of the water, so that the water in the chamber which is filled rises slightly higher than the level in the chamber from which the water is drawn, and the gates separating the chambers become subjected to a reverse head. At Pedro Miguel it is noticed that the water rises from 0.3 to 0.6 ft. higher than the water in the forebay, tending to throw the upper gates open. The difference in head is of short duration, but is very noticeable, and is taken as an indication of the instant when the apparatus for opening the gates should be put in motion. This acts as a safety device to the motors which operate the gates.

In the annual report of the Isthmian Canal Commission for 1911 is described the method used for overcoming differences in pressure on the lower gates at the lower lock at Miraflores and Gatun, due to the difference in density of the water above and below the gates, in consequence of which the culverts were turned up at the outer end so as

to reduce the pressure to a manageable quantity. It is possible that the overtravel of the water from the emptying lock into the tail bay may result in continuing the flow of the fresh water through the culvert beyond the point at which in theory it should cease and, therefore, in obviating the danger of the resultant pressure. However, no trouble is experienced from the resultant pressure against the lower gates. The difference in density of the water above and below the gates is, however, noticeable in another way. When the lower gates are opened the fresh water rushes out with considerable velocity on the surface of the salt water below, and there is a corresponding rush of salt water along the lower strata. This current continues for a considerable time and has a noticeable effect on vessels leaving the lock, sheering them away from the middle wall as soon as they pass the angle of the side wall.

The slope given to the water in the lock by use of the side culverts has already been noted. The same effect was noted during the filling of the lowest lock with fresh water when the lower gates have been left open long enough to insure salt water filling the lock. The slope is from the middle wall so that the ship moves to the side wall and the towing locomotives are unable to hold a large vessel central in the lower lock during the entire process of filling when the side culvert only is used.

COEFFICIENT OF FLOW

As noted in previous annual reports, in the formula for filling and emptying the locks the coefficient of flow C , used to determine the real velocity, was assumed at 0.65, this being slightly more favorable than experience at other locks has shown to be readily obtainable, but the nature of design and construction warranted the assumption. From experiments made at Pedro Miguel when the lake level was at reference 84.8 and the water in the lock was at reference 50.9, the value of C for the side culvert, with both valves open, was determined to be 0.886, much more favorable than was anticipated. Similar observations, using only one valve, were made both at Pedro Miguel and in the upper lock at Gatun as a check, and the value of C was found to be 1.177 and 1.272 at the two locations respectively. The value of the coefficient for emptying the lock at Pedro Miguel is somewhat less favorable than that for filling, the coefficient C for the side culvert being found to be 0.804 when both valves were used. At Gatun and Miraflores, where the culvert is turned up at the discharge, the coefficient of flow for emptying the lower lock is about 8 per cent less than through the level discharge at Pedro Miguel. When the middle wall culvert is used in combination with the side culvert the time of operation is greatly reduced. The Pedro Miguel lock can be filled or emptied in about 8 min. without causing too great a disturbance in the chamber. Observations have not yet been made with the middle culverts at Gatun and Miraflores.

METEOROLOGY AND HYDROGRAPHY

Seismic disturbances during the year were more numerous and severe than in any previous year since American occupation, 87 distinct shocks being recorded at Ancon. Practically all of the shocks seemed to originate in the vicinity of the lower coast of Los Santos Province, approximately 115 mi. southwest of Ancon. The most violent

shocks occurred on Oct. 2, 1913, and May 28, 1914; in each instance a maximum amplitude of 75+ was recorded, when the recording pens were thrown off. The shock of May 28 resulted in slight damage to the new administration building then in course of erection at Balboa Heights, but with this exception the canal works suffered no damage from these shocks.

The main hydrographic features of the year were the filling of Gatun and Miraflores lakes and the subsequent control of their water levels by means of spillway gates, auxiliary culvert valves, etc. The total yield of the Gatun Lake watershed for the calendar year 1913 was 77 per cent of the yearly mean since May, 1908, and 70.3 per cent of the mean for the 24-year period 1890-1913. There were no large freshets during the year.

The rainfall during 1913 was below normal at all stations except Brazos Brook, Colon and Porto Bello. The heaviest precipitation for the year was 171.19 in. at Porto Bello, and the minimum was 59.54 in. at Balboa.

The wind movement over the Canal Zone for the year was slightly above normal. North and northwest winds prevailed. March was the windiest month at all stations, and November the month of least wind movement.

DRY EXCAVATION

The excavation for the canal prism in the dry, uncompleted at the close of the previous fiscal year, embraced the Culebra cut from Gamboa to Pedro Miguel locks, the channel between Pedro Miguel and Miraflores locks, and the channel below Miraflores locks to the dike which excluded the waters of the Pacific. As noted in the previous annual report, a decision had been reached to admit water to the cut by blowing up the dike at Gamboa on Oct. 10, 1913, and to complete the excavation that remained by dredges. With this end in view, the excavation in Culebra cut was carried on during July with an average of 40.74 steam shovels, in August with an average of 34.65 steam shovels, and in September with an average of 14.62 steam shovels. These shovels worked not only in the cut proper but on the upper reaches in the vicinity of Culebra and on the east side opposite Lirio. After the water had been admitted to the cut from 5 to 2 shovels worked on both the east and west bank in the vicinity of Culebra so as to lighten the load. The work on the east bank was continued until April 1, 1914, and on the west bank intermittently until June 15, 1914. The last movement of any considerable amount occurred on the west side at Culebra just as the steam shovels were withdrawn.

There were removed during the year a total of 3,122,702 cu. yd. of material, of which 2,205,847 cu. yd. were classified as rock, at a division cost of \$0.5661 per cubic yard. Due to large credits for material recovered after the completion of the work, such as rails, ties, etc., amounting to about \$260,000, the above figures do not represent the real cost of the work performed during the year which, eliminating these credits, was \$0.6492 per cubic yard. Work continued on Cucaracha slide, Culebra slides, Hagan's slide, Lirio slide, and the powder-house slide until steam shovel operations were suspended and there were removed from these slides 2,635,902 cu. yd.; in other words, 84 per cent of the material removed from the cut was due to slides. The total

amount of material removed in the dry from Culebra cut, from the beginning of American operations to June 15, 1914, aggregated 110,261,883 cu. yd. at a division cost of \$0.7066 per cubic yard; of this amount 25,206,100 cu. yd. were removed because of slides, or 22.86 per cent. This was an increase of 4,940,100 cu. yd. over that estimated in the annual report for 1912. Steam-shovel operations in the cut proper were permanently suspended on Sept. 10, 1913, and at that time it was estimated that 600,000 cu. yd. of material remained to be removed by dredges from the cut section within the original limits of the canal, exclusive of slides and the inclines at the north and south ends of the cut. Practically all of this material lay between Cucaracha slide and a point about midway between Culebra and Empire.

GAMBOA DIKE DYNAMITED

To prevent possible damage to the canal due to the velocity of current caused by the difference in head between Gatun Lake level and the bottom of the cut, water was admitted through the 24-in. pipes extending into the lake under Gamboa dike, these pipes remaining from the old pumping plant located in the vicinity to take care of the drainage water to the north of the divide. This was done at 9 a. m. on Oct. 1. Work on drilling the dike at Gamboa preparatory to its demolition was begun in the latter part of August; the holes were loaded and were fired on Oct. 10 at 2 p. m. In accordance with an arrangement made two or three days beforehand, the blast was fired by President Woodrow Wilson, at Washington. This was effected by using the land telegraph to Galveston, Tex., and connecting it there with the Central & South American Cable Company's submarine cable and land lines, which, by employing the company's transisthmian cable, furnished a connection to a local circuit in the vicinity of the dike. When the President depressed the lever, the current was relayed from point to point along the route and was eventually transmitted to the local circuit, closing it and tripping a weight attached to the handle of a switch. The weight threw the switch, setting off the blast. The result of the explosion was a clear opening 125 ft. wide through which water from Gatun Lake flowed in sufficient volume to complete the filling of Culebra cut from the dike to Cucaracha slide in about two hours' time. Prior to dynamiting the dike the water in the cut was about 6 ft. below the level of the lake.

On Oct. 10, after the blowing up of Gamboa dike, an effort was made to dynamite a passage through the Cucaracha slide in order to flood the cut between the dike and Pedro Miguel locks. Though steam shovels had been at work on the slide with a view to securing a passage through it, on the cessation of this work the movement continued and completely blocked the channel. The attempt to open a passage by dynamiting was not successful, and it was not until Oct. 12 that a stream of water was gotten through and the area to the south of the slide began to fill. The dredges reached Cucaracha slide from the north end on Oct. 20 and from the south end on Oct. 24. The Gamboa dike was attacked by dredges immediately after the explosion. A channel was finally dredged through Cucaracha slide, so as to permit the passage of the dredging fleet from one side to the other, on Dec. 13. With the exception of

a small pocket slide in the vicinity of Cascadas, the admission of water to the cut has thus far had no bad effects; nor has there been any perceptible tendency for the presence of water to produce slides.

The sluicing operations to the north of Gold Hill and to the rear of Cucaracha slide were continued during the year and resulted in the removal of 1,384,455 cu. yd. of rock and earth, at an average division cost of \$0.1997 per cubic yard. This material was carried by flumes into the valley to the east of the canal.

South of Pedro Miguel Locks material amounting to 306,700 cu. yd. was excavated by the fifth division. Of this, 20,510 cu. yd. were from the channel south of Pedro Miguel locks and 286,190 cu. yd. from the prism south of the Miraflores locks. The average division cost was \$0.5134 per cubic yard. The material was used as a backfill to the locks and for sloping the Miraflores dam.

On account of material recovered at the close of the work, credit was given aggregating about \$79,000, so that the actual cost of dry excavation during the year was \$0.7709 per cubic yard. The total amount excavated in the dry from Pedro Miguel to the sea since the beginning of the work aggregated 4,819,969 cu. yd., at a division cost of \$0.6755.

Steam-shovel work south of Pedro Miguel locks was stopped in August and south of Miraflores locks in September, and steps taken to remove all tracks that remained within the limits of the canal channel. The last remaining barrier at the Pacific end of the canal was dynamited at 9.30 o'clock Aug. 31, 1913. This dike, composed of a trestle fill of rock and earth, prevented the water from the sea level from entering the steam-shovel cut, 5,000 ft. long, 500 ft. wide and 46 ft. below mean tide, extending to

Miraflores locks. The Rio Grande diversion was turned into this pit on Aug. 23, but the depth of water had only reached about 15 ft. by Aug. 31. About 37,000 lb. of 45-per cent and 60-per cent dynamite were used, the charge being placed in 541 holes at an average depth of 30 ft. At the time of the explosion the water in the channel south of the barrier was nearly at low tide. The dynamite tore a gap in the dike about 100 ft. wide, but as the bottom of the gap was still at some height above the existing tide level, no water passed through until high tide, at 1.35 p. m. At 3 o'clock, 1 hour and 25 min. after the water first began to flow over, the level in the inside channel was that of the outside channel, while the gap had been widened to 400 ft. or more.

DREDGING

The dredging division continued in charge of W. G. Comber as resident engineer, and was subdivided into two districts, the first extending from deep water in the Pacific to Gamboa, and the second from Gamboa to deep water in the Caribbean sea.

In the first district, between Pedro Miguel locks and the sea, there were removed 5,364,816 sq. yds., of which 3,329,072 cu. yds. were taken from within the canal prism and the balance was auxiliary work. Of the amount removed from within the canal prism, 1,186,432 cu. yds. were of rock. Of the rock excavated, 146,477 cu. yds. were drilled and blasted by the drill barge Teredo and 60,832 cu. yds. were broken by the rock breaker Vulcan. The remainder includes rock which had been drilled by well drills and blasted in previous years and material which could be handled by the dredges without mining. The average cost of prism excavation was \$0.2578 per cubic

yard. Active operations began in Culebra cut on Oct. 23, 1913, and continued throughout the year; a total of 3,432,363 cu. yds. were removed, of which 919,655 cu. yds. were of earth and the balance rock. The average cost was \$0.5194 per cubic yard. Of this amount, 865,015 cu. yds. of earth and 1,557,360 cu. yds. of rock were removed from Cucaracha slide, at an average cost of \$0.4730 per cubic yard. Pipe-line dredges, with the assistance of a relay, pumped over the west bank of the canal into the Rio Grande Valley 684,514 cu. yds. of earth and 77,880 cu. yds. of rock, at an average cost of \$0.2773 per cubic yard. Cucaracha slide has been very active since dredging operations started, the daily movement averaging about 2½ ft. On June 30, 1914, the total area of the slide was 60.4 acres, 44.6 acres active and 15.8 acres without motion. Dredging was done during four months of the year in Miraflores Lake, removing 159,817 cu. yds. of earth from the canal prism, at an average cost of \$0.3179 per cubic yard.

In the second district 6,544,192 cu. yds. were removed during the year, of which 3,692,576 cu. yds. were removed from within the canal prism, 574,630 cu. yds. from old French dump in Limon Bay, and the balance was auxiliary work. The average cost of prism and French dump dredging was \$0.1717 per cubic yard. Of the amount removed from the canal prism, 158,994 cu. yds. were of rock. Of the total amount taken out, there were removed between Oct., 1913, and Feb., 1914, 507,195 cu. yds. of earth and 5,035 cu. yds. of rock from the canal prism just north of Gamboa, from what was formerly known as point 1.

In connection with the Atlantic terminals the dredges removed 18,286 cu. yds. of



OPENING OF PANAMA CANAL, AUGUST 15, 1914—STEAMSHIP ANCON PASSING CUCARACHA SLIDE

earth and 16,015 cu. yds. of rock from the site of the bridge crossing the French canal south of the dry dock, 117,289 cu. yds. of earth from the approach channel, 275,993 cu. yds. of earth and 46,360 cu. yds. of rock from the new piers 7, 8 and 9, and 181,709 cu. yds. of earth and 213,325 cu. yds. of rock from the coaling station. The average cost of excavation at these terminals was \$0.3646 per cubic yard. Seventeen thousand cubic yards were placed in the fill for the substation and 304,411 cu. yds. were placed in fills for bridge foundations, coal basins, and yards at the coaling station.

At the Pacific terminals the dredges removed 1,919,003 cu. yds. of earth and 7,964 cu. yds. of rock, of which 1,831,711 cu. yds. of earth were handled by pipe-line dredges and relays and placed in fills for reclaiming swamp land. The average cost of this work was \$0.1655 per cubic yard.

As noted in the previous annual report, a contract was made with the Bucyrus Co. for the construction of two 15-yard dipper dredges and their delivery at tidewater in the United States. Due to a failure of the buckets, which were not sufficiently strong to do the work, an additional delay was caused. The failure to meet the stipulated dates of delivery resulted in very seriously handicapping the work at Cucaracha slide and delayed securing a channel sufficiently deep and wide to permit the canal to be utilized for the passage of commerce before the close of the year.

The force employed on the canal dropped steadily throughout the year, being 29,673 on June 30, 1914, as compared with 43,350 at the close of the previous fiscal year. Accompanying the decrease there was a large emigration from the Isthmus, and for the first time since the work was started there was an excess of departures over arrivals of about 15,000. Free transportation was furnished to 1,361 Americans, 1,173 West Indians, and 1,615 Europeans, at a cost of \$121,765.80. The character of the force was radically changed during the year, due to the completion of dry excavation.

Illinois Commissioner Favors \$180,000,000 Plan

A. D. Gash, head of the Illinois Highway Commission, has a plan which he will soon advocate, involving the expenditure of \$180,000,000 for permanent highways in Illinois. With this he hopes to build 16,000 mi. in twenty years. Mr. Gash estimates that the increased value of the land, because of these improvements, will much more than pay for them. He predicts that such roads will double the life of road vehicles and in the one item of saving of time to the farmers will more than compensate for the outlay. According to Mr. Gash, \$160,000,000 must be obtained by direct taxation. The other \$20,000,000 will be received from automobile licenses in twenty years. A probable bond issue for part of the expense is also suggested.

A TIE GUIDEBOOK for railroad inspectors is now being prepared by the U. S. Forest Products Laboratory at Madison, Wis. The book, which will be of pocket size, will describe methods for distinguishing the different kinds of ties. The methods will be simple, so that the inspector can easily apply them.

Felling a 400-Ton Brick Chimney with Dynamite

Quick Removal of Abandoned Stack, Traffic on Car Line Alongside Being Delayed Only Five Minutes

RECENTLY, in laying out proposed improvements, the United Railroads of San Francisco decided to take down the remaining portion of the brick chimney which still stood on the site of the old McAllister Street power station, but which had been out of service for many years. Manifestly, the cheapest way to remove it was to fell it all at once, but the ordinary procedure of substituting a wooden foundation which could be burned was not feasible, because one of the main car lines of the city runs



FALLING OF DYNAMITED CHIMNEY

past the base of the chimney and car service could not be delayed as long as it would take the timbers to burn. It was, therefore, decided to put in a timber foundation which could readily be destroyed by dynamite.

The base of the chimney was 14 ft. square, and as the earthquake of 1906 had broken off about 25 ft. of the top, the remaining portion to be felled was 100 ft. high and weighed, on a basis of 100 lb. per cubic foot, 400 tons. On the side toward which the chimney was to fall, seven 2-ft. pieces of 10 x 10-in. timbers were, one at a time, substituted for the brickwork, to carry the weight of the structure while the foundation was cut away 6 in. back of the center line of the chimney. A hole had previously been bored in each end of each of the timbers, and when the foundation was ready a 2½-in. stick of dynamite was placed in each hole, and all were wired up for simultaneous discharge.

The accompanying photographs shows the two main breaks in the chimney which developed when it had tilted to an angle of about 60 deg. with the horizontal. It fell on a line parallel with two sides of the foundation. The chimney was built in 1886 with good quality cement mortar, and the good construction of those days was exem-

plified by the fact that in spite of the great weight of the falling body it did not break up in small pieces, but remained for the most part in large blocks that had to be dynamited again before they could be loaded on cars for removal.

The chimney fell nearly parallel to the car tracks, and service was interrupted for only five minutes. The work of removing the chimney was carried out under the supervision of B. P. Legare, chief engineer of maintenance of way and construction of the United Railroads.

Progress of Federal Railroad Evaluation

Summary of Main Developments to Date, as Reported by General Secretary of Presidents' Conference Committee

DEVELOPMENTS to date of the Federal evaluation are summarized in a new progress report issued by Thomas W. Hulme, general secretary of the Presidents' Conference Committee. Similar reports were abstracted in the issues of May 30, page 630, and July 11, page 52. In the former abstract was given a list of roads on which the Government had started surveys, and a list of those to be surveyed this year. Work has been started on all of those in the latter list with the exception of the Great Northern, and also on the Chicago, Rock Island & Pacific and the Minneapolis, St. Paul & Sault Ste. Marie. The Government has also notified the following companies of its intention to start work on their property in the near future: Atchison, Topeka & Santa Fé; Atlantic Coast Line; Illinois Central; New York, New Haven & Hartford; Philadelphia, Baltimore & Washington; Delaware; Maryland, Delaware & Virginia; Baltimore, Chesapeake & Atlantic; St. Louis Southwestern; Southern Pacific; Southern; Georgia Southern & Florida; Washington Terminal, and New York, Philadelphia & Norfolk.

FIFTY GOVERNMENT PARTIES

On the fifteen railroads on which work has been started there are now about fifty Government parties. Up to Sept. 1 about 5100 mi. had been covered by the roadway and track parties, whose work consists of chaining track, taking pluses to the various items of roadway and track property and taking cross-sections and other measurements for determining quantities in roadway and track and in the smaller structures. Meanwhile separate parties are directing their attentions to bridges and buildings, terminals, signals and interlocking, telephone and telegraph systems, and shop machinery and tools. Computations of quantities are progressing simultaneously with the field work. Attorneys and accountants are examining the carriers' land records, accounts and financial histories. A cost data bureau, as already stated in this journal, has been established at Washington for gathering, filing and analyzing prices of labor and material, as an aid in connection with prices to be applied to the inventories of quantities.

The carriers report a reasonable degree of satisfaction with the Government work, there being a constant effort on the part of the Government parties to ascertain the exact facts. Most of the carriers under survey have from twenty to forty men employed in connection with the work.

Sewerage System for Panama-Pacific Exposition Grounds at San Francisco

Pumping of Sewage, Use of 51-Inch Wood-Stave Pipe, Design of Manholes and Catch-Basins; and Cost of System—Part II

By WILLIAM CLYDE WILLARD

Assistant Engineer, Panama-Pacific International Exposition

IRONSTONE pipe was used in all cases in the main district for 6-in. and 8-in. sizes, and in some cases for sizes as large as 24-in. where the ground was solid. The structures erected over the filled ground have pile foundations because of the constant settlement of the fill, and the sewers under these structures are hung from the building floor on timber brackets, as illustrated by Fig. 3. All sewers thus supported, ranging from 6 in. to 24 in. in diameter, are ironstone pipe. Wood-stave pipe would have been much lighter, also cheaper for the larger sizes, but the difficulty of making numerous taps for service connections, a Y-branch being left each 25 ft., decided in favor of the ironstone pipe. For the larger sizes outside the structures wood-stave pipe was used.

SPOUTS AS VENTILATORS

There are few direct connections to the wood-stave pipe, as most catch-basins and service connections are made at manholes, but where it is necessary to do so, direct connection is made by using a concrete collar. Under the eight central exhibit palaces the ground was borrowed to a depth several feet below the level of the ground outside the structure, in many places the borrow going down to the level of the ground water. Where it seemed probable that water would seep in and stand under the structure a 6-in. vertical standpipe was put on the sewer and made of such length as to extend well above the computed hydraulic grade line. Many of the sewers supported under the buildings will normally discharge under a head of from 1 to 4 ft. A removable, tight cap was placed over the end of the vertical pipe. Each line of sewers under the exhibit palaces has several downspout connections—the downspouts being brought down the building columns—none of which are trapped, as it is intended to let the downspouts act as sewer vents, no other vents being provided.

The system in the State and foreign pavilions district consists of one combined, one sanitary and three storm systems. The larger part of the district is low and flat,

making it impossible to get the sewage to Baker Street without pumping. For this low ground, therefore, separate systems were provided for the storm-water and sewage, the latter draining by gravity into a concrete sump centrally located in the district and having a bottom elevation of -13.4 ft. Forty feet south of the sump was sunk a redwood tank, weighted down against flotation with a concrete casing, and containing two 10-in. horizontal Krogh centrifugal pumps, each connected by a silent chain drive to a 25-hp, 3-phase, 60-cycle, 220-volt, 1800 r.p.m. Westinghouse motor mounted at the same elevation as the pumps. The pump speed was specified as 500 r.p.m.

PUMPING SEWAGE

The pumps are mounted sufficiently below the elevation of the sump bottom so that each pump is fed by gravity through an 18-in. wood-stave pipe. A 6-in. standpipe, carrying a float which operates a float switch, rises from each feed pipe just outside the pump pit. The floats are so arranged that the two pumps are thrown into action at different elevations. As the sump is pumped out, the switch cutting out the motor is thrown as the first float descends, and the motor is at rest until the sewage again rises in the sump and standpipe whereupon it again starts as the rising float throws the switch. The specifications required each pump to have a capacity of 2500 gal. per min., against a 10-ft. head. The discharge from the pumps is through a 20-in. machine-banded fir, asphalt dipped, wood-stave pipe 1168 ft. in length, wrapped for a 50-ft. head.

The sump is constructed in the form of a double manhole with a rectangular flap-gate connecting the two compartments at El. -4.75. One compartment acts as a manhole on a 40-in. storm sewer running directly to the bay. In case the power operating the pump is shut off or the pumps are inactive for any other reason, the sewage will rise in the sump till it reaches the flap-gate and will then overflow into the storm sewer. The flap-gate acts only in one direction, so that should a combination of rain and tide raise the water in the storm sewer above El. -4.75, it will not overflow into the sump.

The sanitary sewer is laid at from 1 ft. above to 8 ft. below the level of the ground-water, and to reduce to a minimum the leakage into the pipes and correspondingly the work of the pumps, wood-stave pipe was used for all sizes 10 in. or more in diameter. The service connections will be infrequent in this district, and where connections cannot be made at manholes a direct connection will be made.

51-INCH WOOD-STAVE PIPE

The United States Government required that all storm sewers in the Presidio which connected in any way with the existing drainage system be of permanent construction. To meet this requirement continuous-

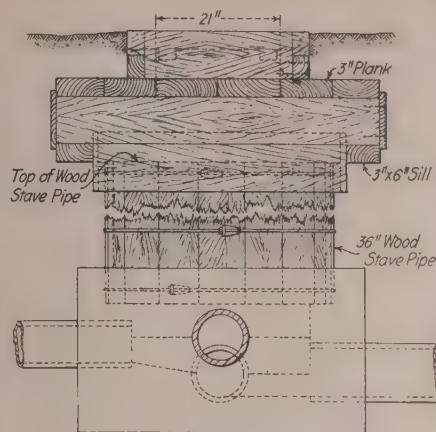


FIG. 6—WOOD-STAVE MANHOLE

stave redwood pipe with galvanized bands and concrete manholes was used. The storm water is now carried by a redwood pipe 46 in. in diameter, at the upper end and 51 in. in diameter at the outfall, the largest sewer built by the exposition.

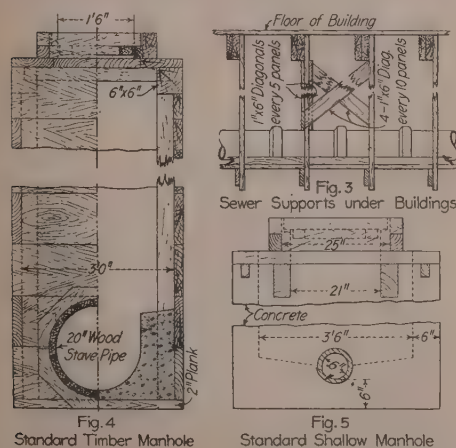
During the first heavy rains of the past winter, a length of about 100 ft. of the 46-in. section of the wood-stave storm sewer floated to the surface carrying a foot or so of backfill up on top of it. This caused some consternation and a hasty checking of computations to see how much more of the various wood-stave pipe sewers might be expected to come up. In designing the sewers this danger was thought to have been amply cared for, and no other trouble of the kind has occurred. Several conditions seem to have contributed to the one failure. The system was then incomplete. The drainage of the newly filled area was imperfect. The filled marsh became so thoroughly saturated that it was practically a liquid, offering very little resistance to the raising of the pipe. In order to prevent a recurrence, a timber platform was placed on the section affected and the deck loaded with sand. No further trouble was experienced.

TYPES OF MANHOLES

Several different types of manholes were used, the first consideration being cheapness and the second, particularly with the sanitary system connected with the pumps, watertightness. Permanence was required on sewers to be used afterward by the U. S. Government. Several types were tried out before the three forms shown in Figures 4, 5 and 6 were adopted as standard. The first of these is all timber and is used where the seepage is moderate and watertightness and permanence are unessential. The second is of concrete with timber top and is used where permanence is required or for shallow depths where seepage is excessive. The third has a concrete bottom, a redwood stave pipe body and detached timber top and is used for depths over 6 ft. where watertightness, but not permanence, is required. For the large wood-stave pipes, special concrete manholes were constructed.

At the time these manholes were designed the character of the roadway pavement had not been determined upon. As the height of the crown would depend on the width and character of the pavement, the manhole tops were designed so that the covers could be raised or lowered to fit the pavement elevation, with very little difficulty. As a rule lampholes were so installed that no pipe run would be over 300 ft.

Sewers under buildings located on hy-



FIGS. 3, 4 AND 5—SEWER SUPPORT UNDER BUILDINGS AND MANHOLE DETAILS

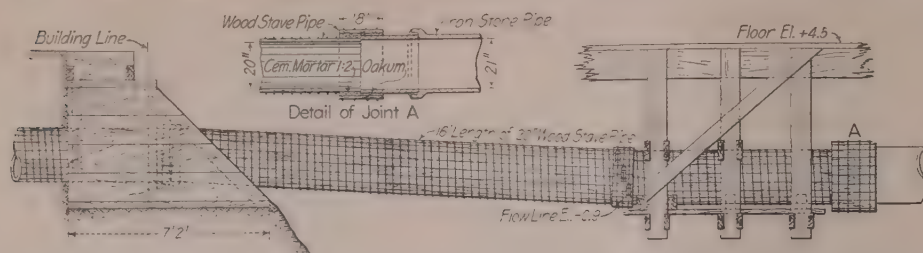


FIG. 7—TRANSITION SECTION WHERE SEWER PASSES FROM SETTLING GROUND TO RIGID SUPPORT

draulic fill are swung from the building floors and consequently receive a positive and unyielding support from the piles forming the building foundation. Where the sewers leave the building and traverse the fill the portion outside the building is liable to certain settlement, while the supported portion under the building remains fixed. The reverse condition also exists in several places, particularly where exposition sewers in the settling fill connect with city sewers, all the latter being supported on deep pile foundations and not liable to settlement. To meet this condition of transition from fixed to yielding foundation for sewer conduit a special flexible short section was designed to connect the fixed conduit with the portion subject to settlement, the latter being set arbitrarily at a lower elevation and the flexible section set at a sufficiently greater slope to connect the two sections.

It was necessary to assume that the run of unsupported sewer would be subject to approximately uniform settlement throughout a given zone and the increased grade in the flexible section was determined as nearly as possible from the observed settlement of the adjacent part of the hydraulic fill. All these junctions so far have proved satisfactory. Through them a drop of from 10 to 15 in., according to location, is allowed for in from 14 to 20 feet. The necessity for providing these settlement joints is shown by the fact that about the middle of March, when the unsupported sewers from the mines and metallurgy palace were connected to the main sewer, it was found that the former were from 8 to 11 in. lower than the elevations shown for them on the plans, none of them having been in the ground more than six months. Fig. 7 shows a typical transition or junction structure where sewer passes from settling ground to a rigid support.

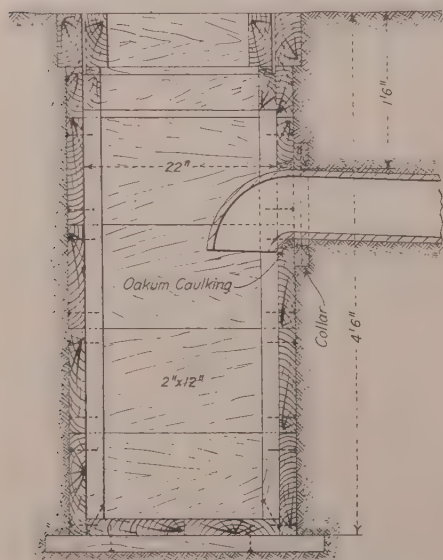


FIG. 8—ONE TYPE OF CATCH-BASIN

Where wood-stave pipe, particularly the larger sizes, enters concrete manholes, the end of the pipe penetrating the wall of the manhole was wrapped with rope oakum protected by a layer of tar paper to prevent absorption of grout from the concrete while being poured. It was desired that the rope oakum would remain flexible and take up the expansion of the wood-stave pipe, due to moisture, and prevent cracking of the concrete manhole. Observation so far indicates the efficiency of this design. All joints inspected are watertight and no cracking of concrete walls has occurred.

CATCH-BASIN DESIGN

The catch-basin design also underwent a growth before a standard was adopted. The first design was nothing more than an open manhole on a storm sewer with a grating top so that the water drained directly into the sewer. Fig. 8 shows the next form tried, a number of which were built. It was expected that the quarter curve of the ironstone pipe extending downwards into the rectangular timber catch-basin would trap the sewer gas, but as the soil was principally sand, it was impossible to build the catch-basin sufficiently watertight to maintain a continuous seal. A 6-in. cast-iron back-water valve was then substituted for the quarter-curve iron-stone pipe. The valve kept out the sewer gas but about doubled the cost of the catch-basin. The last and most satisfactory design is shown in Fig. 9. In this design an oak oil or liquor barrel is used for the sump, a circular hole is cut in it and a quarter bend of ironstone pipe used for the trap. The barrel is watertight and a continuous seal is maintained. The grating top is the same for all types. Besides the other advantages mentioned, the barrel catch-basin proved to be cheapest. In the first cost the barrel catch-basin, set complete, was \$7.75, while the timber catch-basin, with back-water valve, cost approximately \$13.

In all cases lump sum bids were called for, covering all work included in the plans and specifications. Whether it was due to this method of bidding or to the scarcity of other construction work at the time in the city, the majority of contracts were let at unusually low prices.

All ironstone pipe specified was of second quality. Where wood-stave pipe was used the specifications called for standard machine-banded fir pipe wrapped for a 25-ft. head. This was used for all obtainable sizes, the maximum being 22 in. in diameter. Continuous stave pipe was used for larger sizes. Exceptions to these general rules have already been described.

QUANTITIES AND COSTS

The total length of the sewer system as planned and now practically constructed, including catch-basin connections and city sewers within the exposition site is 149,977 lin. ft., or approximately 28.4 mi. The total

mentioned is made up as follows: Exposition sewer system proper, not including catch-basin connections, 101,758 lin. ft.; catch-basin connections, 4, 6 and 8-in. pipe, 28,344 lin. ft., and city sewers within site, 19,875 lin. ft.

In order to give an idea of the size of the system it may be said in concluding, that at the Jamestown Exposition, 12,000 lin. ft. of sewers were laid, ranging from 6 to 10 in. These sewers drained into two concrete wells 12 ft. in diameter and 18 ft. deep, from which the sewage was pumped into Hampton Roads by electrically operated centrifugal pumps. The total number of catch-basins used there was 150, all of pine construction.

The site of the Alaska-Yukon-Pacific Exposition was on high ground of a very dense, clayey texture, so that there the problem of grades and seepage was negligible, making the use of small pipes with

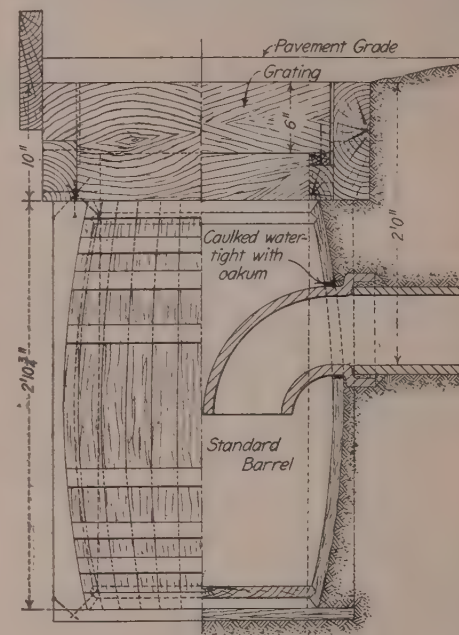


FIG. 9—BARREL CATCH-BASIN

timber manholes and catch-basins possible in every case.

It is impossible to state with absolute accuracy the cost of the exposition sewer system as many drains still remain to be installed at this date. The bulk of the work, however, is accomplished and the accompanying table gives approximate costs.

The apparently low unit cost for sewers installed under item 2 as compared with

COSTS OF SEWER SYSTEM, PANAMA-PACIFIC EXPOSITION

1. Sewers installed under sewer contracts proper—18 separate contracts having been awarded—which included the installation of approximately 53,000 lin. ft. of pipe.....	\$95,780.00
2. Sewers installed in connection with building contracts, which work was done under the plumbing item for the respective buildings, approximately 44,000 lin. ft.....	35,000.00
3. Sewers installed by the direction of the bureau of civil engineering, approximately 32,000 lin. ft., 28,000 lin. ft. of which consists of 4, 6 and 8-in. catch-basin connections; therefore sewers proper laid by the exposition forces amount to about 4,000 lin. ft.	8,313.00
4. Catch-basin connections installed consist of 28,344 lin. ft. of 4, 6 and 8-in. pipe. These were installed entirely by the exposition forces but were charged to roads and pavements and the cost was not segregated from other items of road construction. Therefore no segregated cost can be given	
Total	\$139,093.00

item 1 is accounted for by the fact that a comparatively large proportion of the sewers included in building contracts were of small diameter and their installation was accomplished with a small amount of excavation, the space under the building permitting this.

The apparently high unit cost of the sewers installed by the exposition—item 3—is accounted for in part by the proportion of redwood box culverts installed; and further, the fact that the sewers installed by the exposition consisted of small isolated sections generally in bad ground and which could not consistently be included in contracts.

The plans of the sewer system were prepared and the work executed by the division of works of the exposition company, of which H. D. H. Connick is director and A. H. Markwart, assistant director of works. A large part of the work was designed by the writer under the immediate supervision of E. E. Carpenter, chief civil engineer.

Hydraulic Dredge to Dig to Depth of 100 Feet

Machine Specially Designed for Calumet & Hecla Copper Mining Company to Recover Stamp-Mill Tailings from Lake

A HYDRAULIC dredge has been built for the Calumet & Hecla Copper Mining Company to dig to a depth of 100 ft. below water level. For nearly forty years the company has been depositing in Torch Lake at Lake Linden, Houghton County, Michigan, tailings supposed to be worthless. A process has recently been perfected, however, whereby these tailings can be reworked and the copper recovered, and it is estimated that the amount to be recovered on the shores and in the lake aggregates 40,000,000 tons. The problem encountered as far as it affects the dredge design is somewhat complex. Certain portions of the tailings piles have in the past been used as a public dump, consequently a certain percentage of foreign matter is contained therein. It becomes necessary, therefore, to screen the material thoroughly before delivery. As only part requires screening, however, the design of the dredge had to be such that the screen could be cut out when not required. This led to the necessity of two pumps and a complicated control.

The dredge has a steel hull 110 ft. long, 56 ft. wide and 9 ft. deep. The deck has an 8-ft. overhang, which makes the extreme width of hull 72 ft. The digging ladder is 136 ft. long, requiring a ladder well 70 ft. long and 10 ft. wide. This extreme length of well has necessitated an exceedingly heavy overhead truss.

TWO PUMPS

There are two centrifugal dredging pumps, each of 20-in. diameter. One, driven by a 750-hp motor, delivers material directly from the lake to the screen on the dredge. When this screen is disconnected by changing the pipe connections, it pumps ashore through a pipe line up to 800 ft. in length, and to a maximum elevation of about 30 ft. The other pump, driven by a 1250-hp motor, pumps ashore from the sump under the screen through a pipe up to 2500 or 3000 ft. in length, with a maximum elevation of about 10 ft. This pump is so designed that it may be connected to the suction pipe and thus take the mate-

rial directly from the bottom of the lake to shore. Either pump may be used independently when the screen is not in use. The screen is 7 ft. in diameter and about 45 ft. long, and is made of manganese plates with perforations 1 in. in diameter. It delivers the refuse to a scow alongside.

No cutter head is required, because of the loose character of the material, which has no binder. Hydraulic jets are provided, however, with which to break up the material if necessary. These jets are operated by an 8-in. two-stage horizontal double-suction turbine pump, driven by an independent motor. On account of the great depth of the lake and the soft nature of the material, the dredge works on head and side lines instead of spuds.

Instead of one winch, as is the custom on dredges of this type, the length of the ladder well makes it necessary to have two. Each has four drums for the ladder hoist, two bow swing lines, two ladder swing lines, two stern swing lines and a tail line. Each is driven by an independent 50-hp motor. An air compressor is provided for operating the air cylinders which control the friction clutches. A 6-in. service pump of the same type as the jet pump is supplied for sealing the swivel joints in the suction pipe in order to prevent air leaks. There is also an overhead crane for serving the machinery. As the dredge is to be worked the year around, a 75-hp boiler is provided for heating purposes and for driving the capstans and electric-light plant when the dredge is being shifted and no electric power is available.

BALANCE OF PUMPS

The two-pump feature has necessitated a number of unusual features of control. In the first place the pumps must be balanced, so that the one will not deliver more material than the other can handle. This is pos-

sible as the former is working under a constant load, while the load the latter carries varies according to the length of the discharge pipe in use. This necessitates a careful adjusting of the speeds of the pumps. After thorough study a water rheostat was adopted, said to be the first time that this has ever been tried in the United States for large motors. This device gives an infinite number of speed control points and thus great flexibility. The speed is governed by the height of the liquid in the rheostat tanks, and the flow by a pivoted overflow pipe, which is full on when in a vertical position and off when horizontal. The operator controls the position of the pipe. The liquid must be kept in circulation because of the danger of heating. It is pumped through cooling coils and returned to a storage tank overhead, from which it flows by gravity into the rheostat tanks. The flow is controlled by a valve with an automatic solenoid control. A 3-in. centrifugal pump driven by an independent motor does the pumping. There is also an interlocking electrical control to prevent starting and stopping the pumps in the wrong order.

The dredge was designed and built by the Bucyrus Company, of South Milwaukee, Wis. It is about to be tested at the present time, but will probably not be operated to full capacity until next spring.

UPWARD PRESSURE ON THE DAM at the Coon Rapids hydroelectric development near Minneapolis was cared for by blind drains laid like inverted filters just back of the upstream cutoff wall, as described in the Engineering Record on page 77, Jan. 17. J. W. Link, in a paper on the plant delivered Nov. 16 before the Western Society of Engineers, stated that there has been little leakage into the drainage tunnel and that probably the leakage would lessen rather than increase.



HYDRAULIC DREDGE DESIGNED TO RECOVER TAILINGS AT DEPTH OF 100 FEET

Fourth American Road Congress

Second Group of Abstracts of Papers Presented at the Annual Meeting Held in
Atlanta, Georgia, November 9 to 14—Location, Construction and Administration

Rights of Way

By AUSTIN B. FLETCHER
State Highway Engineer of California

FIFTY feet is a conservative width for right of way. Where possible, 60 ft. should be secured, even in sparsely settled localities. It is inevitable that public utility companies will at some time clamor for locations in the highway, and, although too little attention has thus far been paid to the matter, tree planting and other landscape treatment of our country highways will have to be provided for.

In many of the older sections of the country right-of-way problems are not serious. Ways have been established, well defined and traveled, for many years, and right-of-way improvements consist chiefly in rectifying the side lines of locations where abutting land owners have encroached successfully under the "open adverse possession" statutes which apply in some of the States. In many localities, however, the acquisition of necessary easements becomes as important a factor in the plan and progress of highway work as the road work itself.

It is not alone in cases of new rights of way that there is litigation. Frequently old surveys do not exactly coincide with existing ways, which have become winding and irregular. Owners often build fences or cultivate up to the used portion of the ways, and then resist the shifting of the lines and delay the progress of the work. In many cases much time is lost where owners who have allowed people to pass without objection for years assert adverse claims.

Even when the owners intend to be liberal they exact a great deal of information before signing the deeds of easement. The records have to be searched to ascertain the true owners of the lands affected; owners must be notified or corresponded with; draftsmen are asked to furnish sketches to many owners defining the rights of way desired; visits to the lands must be made and surveys inspected; minor adjustments of lines and fences must be settled upon; vacation proceedings must be arranged and prepared, abandoning the old roads or portions of roads over property so as to leave no incumbrance when the new road is located and built; co-owners must consult among themselves before executing deeds of easement; ownerships involved in probate proceedings or title litigation must be searched and a good title to the roads acquired out of the confusion, and there are other details ad infinitum.

THE RIGHT-OF-WAY MAN

These many difficulties have led, in the writer's Western experience in highway work, to the employment of the subtle right-of-way man, who needs to be a psychologist as well as a philosopher. His chief duty consists in attempting to wheedle the land owners into signing the needed conveyances and to convince them that their duty to the public lies in giving their property gratis. In addition to the right-of-

way man and his assistants, the help of an attorney learned in eminent domain practice has been had, who devotes all of his time to the highway work and whose principal activities are in right-of-way matters.

In many jurisdictions, if the deeds cannot be acquired by diplomatic methods, war must be declared in the courts, and the highway board must wait.

SETTLING DAMAGE CLAIMS

There is a great lack of uniformity in the different States in the methods of settling damages in taking property for highway purposes. In some it is not necessary for the authorities to pay for property taken in advance of the actual taking of possession. The property owner has been provided with a method of making his claim and with a tribunal constituted so that he may enforce his claim and obtain his damages therein. In such jurisdictions highway work may speedily progress. The property owner, if he is dissatisfied with the original offer of payment or the award made to him by the public authorities, may pursue his remedy in the appropriate court even though his land has already been occupied by the public. The public has the advantage of celerity in the progress of its enterprise; the land owner is protected by ultimate and adequate compensation for his injuries, and, in one State, at least, he may wait until after the highway is completed before filing petition for jury trial, it then being evident to all interested parties just what damage has been done, not only by reason of the land taken, but by the road construction as well.

Some States are harassed in their public work by constitutions and statutes expressly requiring prepayment before entry upon the land required for public use. The writer has had to do with highway activities in two States, one using the former, the other the latter system. No rights of way, in States having regulations similar to the latter, can arbitrarily be taken by the people before the same, after a vast amount of red tape, have been acquired by donation, purchase or condemnation. Consequently obstinate land owners are able to "hold up" the community at large until it either pays the demands or contests the question of compensation and damages in trials, the latter usually requiring considerable time, particularly in the case of belligerent or indifferent land owners residing in other States or foreign countries. The Western States appear to be particularly oppressed by such roundabout methods of entering upon private property and installing improvements for the benefit and welfare of millions of people. Such a system is absolutely hostile to progress; the people should be greater than the individual.

TOO MUCH ATTENTION TO CLEAR TITLES

Too much attention can be given to the title technicalities of right-of-way activities. It has been an almost universal practice for public boards performing road work to obtain exhaustive abstracts of

title. The writer has had under his supervision the acquisition of hundreds of miles of highway right of way in California where the securing of rights of way could not be made much more difficult, complex or annoying; yet the purchase of expensive abstracts of title has been dispensed with. Out of hundreds of ownerships affected, not one serious complication has resulted from the following plan:

When the field parties are making the original surveys the chiefs of party inquire from the occupants of the land surveyed who the owners or those interested in the property are. This gives a clue to the ownership. One of the staff visits the proper county offices and deeds or agreements are prepared, containing the proper descriptions. Rarely has objection been made to the accuracy of the instrument submitted. By thus performing its own title searches, even though they may not always have been the most exact from a title lawyer's standpoint, the authorities have saved thousands of dollars and have never had an injunction or ejectment proceeding instituted against them.

In most States title may be obtained to ways by the passage of time. It has been the custom in California where the present traveled roads are wide enough to use and properly located, to place the monuments, build the pavements and assert jurisdiction thereover, the theory being that if the owner objects, the authority's title being fundamentally weak, the State can condemn as rapidly as the alleged owner can oust.

In trying to establish old right-of-way lines in anticipation of highway improvements much difficulty is often experienced in finding any landmarks to indicate what the right of way really is, and the old surveys and plans often prove to be of little assistance. Often the roads to be taken over and built as State highways were laid out when the land was of little value and the surveys were carelessly made or the descriptions carelessly recorded. In all State work with which the writer has had to do it has been the policy to fix the right-of-way lines on the ground by setting proper monuments into the soil to such a depth that they serve as markers for all time to come.

State Control of Road Construction

By A. N. JOHNSON

Bureau of Municipal Research, New York City

SOME of the facts to be noted from the accompanying table are as follows: There are but seven States without State highway departments. There have thus been created in the last twenty years thirty-six State highway departments. Of these thirty-four have State-aid roads, that is, specific pieces of road which are constructed in part by State funds; five of the State highway departments have no commissioners, only a State engineer; while fifteen have State commissioners and no State en-

gineer. It is thus seen that a majority are organized with a commission and State engineer.

The commissions are appointed in part or in whole in thirty-one States, while in fourteen they include ex-officio members. In but one State is the commissioner elected, and in seven only are any qualifications required. In twenty-seven the State engineer is an appointive officer. In no State is he an elective officer, but in six only are qualifications required. Where any qualifications are required they are for the most part among the recently enacted laws. State highway legislation could be much bettered if qualifications were required in all States where State engineers exist, but it is at least some satisfaction that the State highway engineer is in no State an elective officer.

The method of paying for State-aid roads varies in different States, and it varies for different roads in the same State. Some States, for example, have a certain system of highways for which the State pays all the cost, while on another system of roads the State and county divide the cost. There are fifteen States in which the State pays the total cost on State-aid roads, although some of these States also share with the county or town in the construction of other State-aid roads. There are twenty-six States in which State-aid roads are built by the aid of the State and county, two in which the State and town are contributors; two in which any assessment of the cost of the State-aid road is borne by the adjoining property. It is thus seen that most States consider that State-aid roads should not be paid for by assessments on adjoining property.

PROVISION FOR ENGINEERS

Perhaps the greatest significance attaches to the fact that there are fifteen States in which local highway engineers are provided for by statutes. This is in considerable contrast to the opinion that road work could be done by anybody and did not require any skilled supervision. But the fact that in no

more than a third of the States are local engineers required by statute shows that the appreciation of skilled control has not spread to the extent that it should. The work that has been accomplished by the highway engineers in the past ten years in this country has demonstrated beyond further argument the need for such control.

The work done in many States, particularly in Illinois, has demonstrated the efficiency of road construction by day labor. The State furnishes the skilled supervision and the more expensive machinery, the locality, the labor and teams. There is a two-fold benefit gained by handling the work in this manner: The quality of the work desired is more readily obtained, and the work is done at a cost to the community less than possible by contract. Where State control of road work exists and extends into the concerns of the smaller units, it is possible for a much greater variety and amount of work to be handled by day labor than would be at all wise or practicable if the skilled supervision that the State highway department can furnish the localities could not be obtained.

What has been realized from State control of road work may be thus summed up: The development of a system of main highways adapted to modern motor-freight traffic which promises such great economic changes in both rural and urban life, an increase in the efficiency of local road officials in the expenditure of the local taxes by preventing useless undertakings, by suggesting economic forms of construction and by increasing the economic service of the highways by concentrating expenditures on important roads and preventing waste on unimportant ones, and the prevention of numerous accidents and fatalities by the construction of safe bridges and elimination or treatment of railroad grade crossings in such a manner as greatly to lessen the danger from them. Experience has demonstrated that these ends are accomplished by State control of road work and only by such control.

How to Improve Highway Contract Work

By JOHN J. RYAN
Secretary, New York State Road Builders Association

LATE fall, winter and early spring are the best for highway lettings, inasmuch as the contractor has practically closed his work and has plenty of time to go over new jobs, being in a position to bid intelligently on these contracts. The State or county would gain by having lettings at these times, as they would receive more bids and, undoubtedly, fairer prices for work.

There seems to be a reluctance on the part of most highway departments to furnish information to bidders. Never yet has a State or county lost money by allowing a contractor to know in advance all that there was to be known about a contract which was advertised for letting. In New York State it has been the practice, after advertising highway contracts, to furnish the contractors with the engineer's figures showing how the engineer has arrived at his estimate by computing basic prices, with profit allowance. While some of the old guard of contractors state that they prefer no engineer's estimates, yet, in general, the road builder in New York looks for these estimates on each road and checks up the same with his own idea of cost prices, making allowance for methods and supervision. It has yet to be found that New York lost any money by this procedure; rather has it benefited by it, because the contractor, when furnished with full information as to the contract, is in a position to bid closer and know what he is doing when bidding.

On the day appointed for the letting the bids should be in at a specified hour, opened at that time and read publicly, item by item, with the total amount of contract price. This practice advises the contractor immediately whether he is low, and he is in a position to make arrangements about plant, materials and labor, pending the official award. This award should not be held up more than twenty-four hours, unless for some unforeseen cause. It ought not to take more than twenty-four hours to make a recapitulation of any number of highway bids. In New York State, where on one day they have as many as thirty roads with three hundred bidders, the checking up is done at the same time the bids are read, and the award is made that day or the next morning. This allows the contractor to arrange for his bonds and the other necessities in connection with the preliminary part of his contract.

BONDS AND MONTHLY ESTIMATES

Performance bonds for highway contracts should exceed 50 per cent of the contract price. Such a bond becomes a liability when the contractor signs it, and while it may be called paper liability, yet it has effect upon his credit and sometimes acts as a hindrance in securing other contracts. Some States ask for a bond of 100 per cent, which is quite needless and an inheritance of old and obsolete requirements.

The monthly estimate is the vital thing to the contractor. There can be no successful contract without prompt monthly estimates. These must not be irregular nor must they be pruned. Monthly payments to the builder are as food to the body. In some States 90 per cent of the monthly estimates taken about the twentieth of the month are

STATE CONTROL OF ROADS

STATE	STATE HIGHWAY DEPT					STATE AID ROADS					OTHER ROADS										
	COMMISSIONERS			STATE ENGINEER		PAID FOR			CONTROL		LOCAL ENGINEERS REQUIRED BY LAW					PAID FROM					
	APPOINTED	ELECTED	BY STATE	BY COUNTY	BY LOCAL	STATE	COUNTY	LOCAL	STATE	COUNTY	LOCAL	STATE	COUNTY	LOCAL	STATE	COUNTY	LOCAL	STATE	COUNTY	LOCAL	
ALABAMA																					
ALASKA																					
ARIZONA																					
ARKANSAS																					
CALIFORNIA																					
COLORADO																					
CONNECTICUT																					
DELAWARE																					
FLORIDA																					
GEORGIA																					
IDAHO																					
ILLINOIS																					
INDIANA																					
IOWA																					
KANSAS																					
KENTUCKY																					
LOUISIANA																					
MAINE																					
MARYLAND																					
MASSACHUSETTS																					
MICHIGAN																					
MINNESOTA																					
MISSISSIPPI																					
MISSOURI																					
MONTANA																					
NEBRASKA																					
NEVADA																					
NEW HAMPSHIRE																					
NEW JERSEY																					
NEW MEXICO																					
NEW YORK																					
NORTH CAROLINA																					
NORTH DAKOTA																					
OHIO																					
OKLAHOMA																					
OREGON																					
PENNSYLVANIA																					
RHODE ISLAND																					
SOUTH CAROLINA																					
SOUTH DAKOTA																					
TENNESSEE																					
TEXAS																					
UTAH																					
VERMONT																					
VIRGINIA																					
WASHINGTON																					
WEST VIRGINIA																					
WISCONSIN																					
WYOMING																					
TOTAL	31	1	7	14	27	6	34	21	7	15	26	2	2	24	3	17	16	5	3	10	39

DATA OF STATE-ROAD ADMINISTRATION IN THE UNITED STATES

paid before the first of the next month; that is, practically all monthly estimates are paid within ten days. Records in the New York State department will show these statements to be true. If New York can do it, other States can.

When the first monthly estimate comes around the contractor, if he is a real, live contractor, will have his cost data and his monthly reports figured so that he knows how much work has been done and at what cost, and is in position to take up the matter with the engineer. Together they can check up and agree upon what the estimate should be, so that there will be no deficiency when the check comes to the contractor. Every contractor should keep accurate account, by daily time reports, of every one on his payroll, and of the time and amount of work done. Only in this way can he keep tab on his job and be in a position to put up a fight for what is his when the estimate time comes around.

Convict Labor in Virginia

By GEORGE P. COLEMAN
State Highway Commissioner of Virginia

THE Virginia convict road force is composed of all male convicts who are considered safe by the superintendent of the penitentiary, and all male jail men more than sixteen years of age, and this force, when placed on a county road or in a county quarry, is guarded, fed, clothed and transported at the expense of the State. This about equally divides the cost of the road work between the county and the State.

The Legislature of 1906 appropriated \$25,000 for the maintenance of the convict road force for eighteen months, and the last Legislature appropriated \$145,000, together with the jail fees, which will give us about \$180,000 for the maintenance of the force for 1914. Since the organization of the department we have used convicts in thirty-seven counties and at the present time are maintaining camps in thirty-one counties, representing about 1100 convicts and 500 jail men working on the roads of the State. It has cost the State during the last year to clothe, feed, guard and otherwise provide for this labor, approximately 51 cents per ten-hour working day.

It is quite impossible to compare convict labor with free labor unless you are working them side by side and under exactly the same conditions. I have heard a great deal said about the inefficiency of prison labor as compared with the same class of free labor, the usual argument being that you cannot expect to get the same results from men working under compulsion and without compensation and hope of advancement. From eight years' experience we are of the opinion that prison labor properly handled, that is, with intelligence and humanity, is just as satisfactory and efficient as any other class of common labor, with the additional advantage of being regular and under perfect control. You are in a position to train each man for his particular work and to derive an immediate benefit from that training.

DRAWBACKS

We have found that working convicts on the roads is not without its drawbacks. In many sections of the State the work is light and it is not always advisable to string the men out as needed. Nor is it possible or economical with the funds in hand to

employ a sufficient number of guards. Our experience has led us to believe that the most economical results can be obtained from prison labor working under guard when the labor is concentrated and is worked near their headquarters. One thing is certain—the use of prison labor on the roads in Virginia has quickened the demand for better roads and given an impetus to the movement that nothing else has ever done.

The superintendent of the penitentiary proposes to make an effort to get the Legislature to provide an appropriation with which to pay each prisoner who obeys the rules 5 cents for each day's work. This will amount to something like \$15 per annum and it is proposed to pay that amount to the prisoner on the completion of his sentence. This will permit the discharged prisoner to have a small amount of money to start with on his release. It is hoped that some such law will be enacted at the next session of the Legislature, for according to our present law the prisoners are discharged without help of any kind other than their transportation, except such as is voluntarily given by the sergeant or men in charge of the road work.

I would like, however, to suggest grouping the prison population into four classes, as follows: (1) Long-term and dangerous men, (2) short-term men, (3) trusties, (4) paroled men.

Economy in Grading

By A. D. WILLIAM
Chief Road Engineer of West Virginia

IN the table herewith are comparative costs for moving earth by various methods. The figures are based upon a wage scale of 15 cents per hour and capable supervision. The economy of machinery is apparent. Experience in West Virginia has also furnished some instances where State or county forces have completed excavation contracts at prices well below the cost to contractor.

In McDowell County a contractor failed on a contract at 65 cents per cubic yard, for a material running about 60 per cent soft sandstone rock and 40 per cent earth. The county purchased a steam shovel and moved the material at a cost of 19 cents, including explosives, drilling and shooting. This was casting work on heavy hillside grade. The contract price to the county was \$13,000 for the 20,000 cu. yd. The cost of the labor and explosives and the upkeep of the machine was \$3,800; the cost of the machine, in-

cluding drill and compressor, \$5,500—a total of \$9,300, leaving the county a profit of \$3,700 in cash, and the equipment.

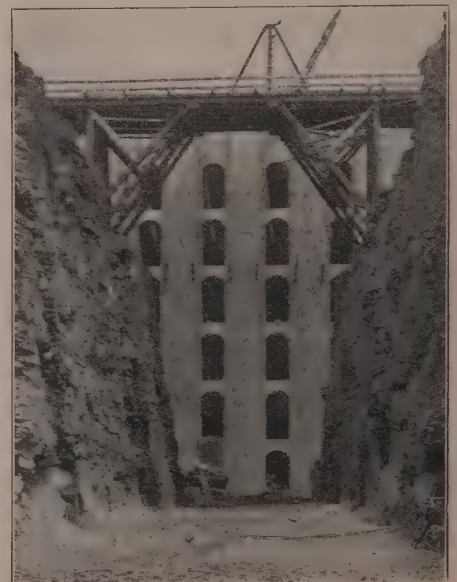
In Pleasants County material running about 80 per cent rock and 20 per cent earth costs 83 cents per cubic yard to grade by day labor at 20 cents per hour; teams cost \$3.50 per day. On the same job prison labor at 75 cents per day and teams at \$3.50 did the work for 30 cents per cubic yard. Contract prices for a 3-mi. job in Kanawha County are \$1.25 for stone and 34 cents for earth. As 70 per cent of the material is stone, the average unit price is 97.7 cents. The State has a prison camp working on the honor system under a competent engineer and is moving the same class of material at 24 cents.

The writer would therefore suggest the use of machinery wherever possible under competent supervision, and of State and county prison labor. On work that is light and on which machinery can be employed the work should be done by day labor. On heavier work and large quantities, contracting is preferable, and the contractor should organize his work systematically so as to get the most efficient service from his men and equipment.

Ashokan Upper Gate Chamber

THE upper gate chamber of the Ashokan reservoir which impounds 132,000,000,000 gal. of water for the New York City's Catskill supply, is a concrete structure built in rock excavation 100 ft. deep, on the line of the east and west channels, and serves to control the direction of flow from east and west basins of the reservoir. It acts as a switch, enabling various combinations of connections to be made between the basins, the aqueduct and the waste way.

It has four wells 100 ft. deep, equipped with twenty-four 3 x 8-ft. sluice gates and 60-in. gate valves, in addition to smaller 36-in. valves, all of them operated by electric motors. The wells extend entirely through the structure and on both reservoir faces have full height openings 6 ft. wide, as shown in the illustration, with the walls between them braced by reinforced concrete portals. They are fitted with shutters, enabling the water to be delivered to or from either basin at any height in the range of 100 ft.



ASHOKAN GATE CHAMBER

COMPARATIVE COSTS PER CUBIC YARD FOR MOVING EARTH

Distance hauled, ft.	Equipment					
	Wheelbarrow	Drag or slide scraper	No. 1 wheel scraper	No. 2 wheel scraper	One-horse cart	Wagon
100	\$0.057	\$0.090	\$0.100	\$0.100	\$0.056	\$0.095
200	0.114	0.135	0.130	0.125	0.068	0.103
300	0.170	0.180	0.160	0.150	0.080	0.111
400	0.230	0.225	0.190	0.175	0.090	0.119
500	0.285	0.270	0.220	0.200	0.101	0.127
600	0.342	0.315	0.250	0.225	0.112	0.135
800	0.457	0.405	0.310	0.275	0.135	0.151
1000	0.570	0.495	0.370	0.325	0.160	0.167
1500	0.857	0.720	0.520	0.450	0.214	0.207
2000	1.143	0.945	0.670	0.575	0.271	0.247
3000	1.713	1.395	0.970	0.825	0.388	0.327
4000	2.280	1.845	1.270	1.075	0.500	0.407

Cost of loading by hand, 5 cents for wheelbarrow, 1 cent for scraper of any type, 13 cents for cart or wagon.

Cost of loading cart or wagon by steam shovel, 6 cents.

Regulating a Troublesome Stream at Watervliet

Improvement Includes Reservoirs to Retard Freshets and Sewers to Carry Runoff under Streets of Populated Section

DRY RIVER, which has for years been a nuisance in the city of Watervliet, N. Y., has been boxed in and provided with reservoirs of the dry type to regulate the runoff from rapid-rising freshets. Watervliet is situated on the west bank of the Hudson River, 5 mi. north of Albany, and opposite Troy. The stream known as Dry River entered the northwest section of the city and flowed through a winding channel in a general southeasterly direction, discharging into the Hudson River at the Watervliet Arsenal. Along the westerly limits of the city the hills rise abruptly from the valley to an elevation of about 200 ft. The stream follows a tortuous course through these hills from the ridge dividing the Hudson and Mohawk watersheds. For about 1 mi. west of the city it flows through a deep and precipitous gorge, which eventually opens out upon the comparatively level river plain where the gradient is light.

Practically the entire watershed is under a high state of cultivation and is well and rapidly drained. The soil is mostly impermeable clay. The country is open and undulating, and the aforesaid conditions, together with the steep gradient of the stream, cause the water from melting snow and ice and even moderate storms to be discharged so rapidly as to result in overflows in the lower stretches of the stream.

ORIGINAL CONDITIONS

Before the works for regulating the flow through the city were constructed many culverts had been built to carry streets across the stream, and the waterway had become more or less obstructed by structures arranged to meet individual requirements. In the summer the stream became practically dry except for pools which served as catchalls for refuse, garbage and sewage. The filth accumulated between storms was deposited over the streets and in the cellars during freshets, which were frequent and often occurred without sufficient warning to allow any preparation. During the winter months, when ice formed, the culverts would clog and force the water over the streets.

A tributary known as "Gas House Creek"



LOWER DAM WITH OUTLET WORKS

emptied into Dry River about $\frac{1}{2}$ mi. from its mouth, and like the main stream, was an eyesore, a source of constant expense and annoyance and a danger to the public health.

Various schemes for improvement had been discussed and some were tried, but these were limited in their scope and were of a local rather than of a comprehensive nature, and generally succeeded in bettering one place only to the detriment of another.

CONTROL WORKS

In 1910 it was determined to devise a suitable plan for the permanent improvement of the stream. A commission authorized by the State Legislature and known as the Storm Sewer Commission engaged a firm of consulting engineers to make the necessary investigations. From detail surveys and a study of conditions it was found that the discharge of flood waters could be regulated by two dams in the narrow gorge west of the city and that the water, after being discharged from the reservoirs, could be led to the Hudson River through a reinforced-concrete conduit built for the most part in the bed of the stream. The two reservoirs are designed to remain empty except in times of freshet, and their principal function is to impound temporarily a part of the flood discharge.

An earth dam 85 ft. high was erected at the upper end of the gorge, where the valley broadens out into a large open basin forming a reservoir of sufficient capacity to regulate the stream above the dam. About $\frac{1}{2}$ mi. below the earth dam a reinforced-concrete dam 25 ft. high was built. This receives the water from the upper dam and regulates the discharge from the intervening drainage area. The control works on both dams are designed to work synchronously and automatically, with a minimum of attention.

The concrete conduit carrying the water to the river is begun 1200 ft. below the lower dam and follows the bed of the stream in a general way to the head of Twenty-first Street, which is about $\frac{3}{4}$ mi. from the mouth of Dry River. Advantage is there taken of a direct route to the Hudson, the line being carried eastward through Twenty-first Street, 1850 ft. to the river, passing under the Erie Canal through a special conduit. The conduit ranges from $6\frac{1}{2}$ to $8\frac{1}{2}$ ft. in diameter, increasing in size to accommodate the city storm sewage and the Gas House Creek conduit, which empties into the main conduit at the head of Twenty-first Street.

A concrete sewer ranging from 3 to $4\frac{1}{2}$ ft. in diameter is built in the bed of the stream below the point where the main conduit leaves the old channel. This serves to carry away the storm sewage formerly entering the stream from the adjoining streets. It discharges into the Hudson along the old course of the creek. Another sewer intercepts Gas House Creek through an open canal section and discharges into the Dry River line at the junction chamber on Twenty-first Street. Provisions for intercepting street drainage and for future extension were made along the line of both sewers.

The upper dam is of earth and is built across a narrow gorge about 40 ft. wide



UPSTREAM VIEW OF UPPER DAM

at the bottom, broadening out to a width of 500 ft. at the crest of the dam, which is 85 ft. above the bottom. The crest is 20 ft. wide. The upstream slope is $2\frac{1}{2}:1$ and the downstream slope 2:1. Berms 8 ft. wide are built at mid-height on both slopes, and the drains carry the drainage to the toes of the slopes. The upstream slope is paved with old street paving blocks to a point 10 ft. above the berm, while the downstream slope pavement is stopped 15 ft. above the foot of the slope.

A reinforced-concrete core wall 6 in. thick on a base 3 ft. wide was carried down into the rock. The core wall was built in lifts of from 6 to 8 ft. The concrete work was carried on simultaneously with the earth work, and special attention was paid to obtaining a good bond between old and new work by means of steel plates.

INLET TOWER

To eliminate moving mechanism and make the operation of the discharge works independent of manual control a system of orifices, adequately protected against freezing and clogging, was deemed best suited for the purpose of regulating the entering waters. Accordingly these orifices were placed in a circular tower of reinforced-concrete. The smallest opening, 12 in. in diameter, is intended for the minimum summer flow. In the winter the 12-in. valve will be closed and the normal flow will be discharged through the 18-in. opening in the side of the tower. When the flow increases above the capacity of this opening the water rises to the grated openings set spirally into the tower walls. These openings are five in number and extend to near the top of the tower, where they are capped by a ring of smaller openings extending around the entire circumference. The orifice in the tower floor, which is located above the 18-in. side opening, discharges the water into a granite-lined well, whence it passes downstream to the second reservoir. As the stream flow increases the reservoir fills until such time as the discharge through the tower equals the rate of runoff, when equilibrium is reached and the water level remains constant. It begins to recede as the inflow diminishes. A study of past storms indicates that the reservoir will seldom be filled to any of the higher levels longer than 48 hr.

The lower dam is a reinforced-concrete structure 25 ft. high and 105 ft. long at its crest. A spillway 72 ft. long is located over

the central section of the dam. The regulating or discharge works are similar to those at the upper dam.

A depression in the crest of the hills enclosing the upper reservoir forms almost a natural spillway. This depression opens out into a small tributary of Dry River, which enters the stream about $\frac{1}{4}$ mi. below the dam. In case the reservoir should ever become filled the water would flow through this channel to a concrete spillway extending across it and be discharged upon a paved semi-circular apron, whence it would be carried through an open concrete-lined canal section to the small stream.

The concrete conduits are mostly of the standard horseshoe type and range from $6\frac{1}{2}$ to $8\frac{1}{2}$ ft. in diameter. The thickness of walls, arch and floors and amount of reinforcement vary according to the depth and nature of the trench, but for any one diameter of sewer the same Blaw steel forms were used and all changes were made in the outside dimensions. In that part of the work built through solid rock a special section permitting a narrower trench was used. This section was composed of 8-in. vertical concrete walls with an 8-in. floor sloping toward the middle, and a brick arch top.

The bed of the Erie Canal being lower than the arch line of the $8\frac{1}{2}$ -ft. sewer, a special section was substituted to avoid a siphon. The invert grade was maintained and a twin box culvert 4 ft. in height was substituted, built so that both ends sloped and converged into the standard section.

OPERATION OF SYSTEM

The two dams create dry reservoirs, which retain water only at freshet periods. The normal and ordinary flow passes downstream without interruption. At freshet stages the orifices in the upper-dam intake discharge the water at the desired rate through the reinforced-concrete tunnel under the dam. The flow of the stream over and above this amount is held in the reservoir, which is of sufficient capacity to allow an ample factor of safety for contingencies and to provide against the worst storms on record. On leaving the upper reservoir the water flows into the drainage basin of the lower reservoir, which is of smaller capacity, and the orifices in the intake are designed to care for the combined discharge from the upper dam and the intervening drainage area.

During freshet stages the water from the lower dam flows over the solid rock bottom of the stream for a distance of 1200 ft. to the sewer intake and thence to the Hudson. A 22-in. steel pipe serves to conduct the water from the lower dam into the sewer at periods of low flow. The main purpose of this line is to prevent heavy ice forming over the shoals and choking the sewer intake at the spring break-up. The intake to this line is arranged to prevent freezing; exposed sections are protected and the discharge end enters the sewer about 200 ft. beyond the intake, where no ice of any consequence will form.

During the heavy spring freshet of 1914 the system, although still incomplete, is said to have worked very satisfactorily, not a street being inundated.

The total cost of the improvement was \$165,000. Solomon, Norcross & Keis, of Atlanta, Ga., were the consulting engineers who planned and executed the work, with F. J. Keis in active charge. The Leary & Morrison Company, of Fairport, N. Y., was the contractor.

Double-Track Steel Ore-Stocking Trestle

Box Girders Spanning 114 Feet Supported on Single Cylindrical Columns Are Found More Economical Than a Wooden Structure

A DOUBLE-TRACK steel trestle, 2594 ft. long and 42 ft. high, used for the stocking of iron ore and having eight 114-ft. spans on either side of the mine shaft, with a 500-ft. curved section at the shaft, is in operation at the Negaumee mine in Michigan. The trestle is designed for a live load of 10 tons. At the shaft the ore is dumped into special saddle-back cars of about 5-ton capacity. These cars are operated by the tail-rope system with power

across the long dimension of the slab.

The columns consist of $\frac{1}{4}$ -in. steel shells filled with concrete. The upper $28\frac{1}{2}$ ft. of these shells are 4 ft. in diameter, while the lower 10 ft. flare to a diameter 6 ft. at the bottom. Six heavy anchor bolts set in sections of pipe hold the steel shell to the foundation. At a point about 20 ft. above the base the reinforcing rods are attached to and properly distributed around two horizontal rings in the shell. Above these rings



DOUBLE-TRACK STEEL ORE-STOCKING TREESTLE WITH CONCRETE-FILLED COLUMNS

furnished by two 75-kw motors. The cars dump automatically at desired points when running over dump-jacks. By shifting a lever at one end of the car three grades of ore can be stocked from each track.

On top of the plate girders, between the rails, the $\frac{5}{8}$ -in. rope is carried on wooden rollers. At the end of the trestle it passes around a 2-ft. sheave and the return rope is supported below the tracks on small sheaves spaced about 30 ft. apart. Slack is taken up by four special tighteners placed at the end of each track. Each tightener consists of a truck to which a 2-ft. roller-bearing sheave is attached at one end and at the other a rope passing over a stationary sheave and supporting a large iron bucket suspended below the trestle.

SUBSTRUCTURE FOR TREESTLE

In the accompanying photograph is shown the trestle, which is supported on round piers 114 ft. apart. The foundation consists of pyramid-shaped reinforced-concrete bases 6 ft. deep, made up of three rectangular slabs 2 ft. thick, one on top of each other, the lowest being 12 ft. wide and 26 ft. long. Fifty-two $\frac{7}{8}$ -in. round rods radiating through the base and extending up 20 ft. into the columns serve as reinforcement. At the bottom of the pyramid these rods are tied to seven old rails laid

other rods are spliced so that the reinforcing extended to within a few inches of the top of the columns. As soon as one span was bolted together two shells were filled with concrete.

As it was feared that the dumping of concrete might throw the columns slightly out of line if the shells were filled in one operation, they were filled about half full one day and completed the next. Afterward the surface was rounded off with a rich mixture and made as smooth as possible to keep water from getting between the concrete core and the steel jacket.

SUPERSTRUCTURE

On top of each column the girders rest on horizontal 8-in. beams supported by four 45-deg. braces. There are two diagonal beams connected across the girders by four other beams. To reduce the free length of the braces they are braced at the center points against the top of the column, as shown in the photograph.

The girders are spaced 20 ft. on centers. The girders are box-shaped and consist of two $\frac{1}{4}$ -in. plates 42 in. wide, and four angles. Diaphragms are provided at intervals. At the columns and supported on the beams are two 38-ft. girders. Intermediate girders 76 ft. long close the gap between the 38-ft. column girders.

TABLE 1—COST OF TRESTLE
Eighteen Piers

	Amount	Per yd.
Excavation, 1800 yd.	\$ 994.65	\$.553
Concreting, 1352 yd.	5,142.70	3.80
Bolts, washers and forms.	2,167.94	2.185
Reinforcing steel.	1,423.89	1.053
Total.	\$9,729.18	
Average cost per pier.	540.41	
Steel Trestle, 2594 Ft.		
Lin. ft.	Amount	Per ft.
Steel erected.	\$35,100.00	\$13.53
Columns (18).	2094	4.65
Small piers for curved trestle (20).	500	1.28
Decking.	500	3.74
Ties and fastenings.	2094	.78
Walk and railings.	500	.72
Temporary tracks for unloading.	2594	.14
Rail and laying.	2594	.60
Total.	\$51,228.92	\$19.71

On the curved part at the shaft bents built up of angles and channels have been substituted for the columns. The stringers are channels and beams of various sections. In the top flanges of the beams are holes for the bolting down of 5-in. nailing strips to which 5 x 7-in. timbers were spiked to serve as ties. On the girders 40-lb. rails are spiked to 5-in. sawed ties 4 ft. long, and on the outside of the girders these ties are bolted to 4 x 4-in. timbers placed against the webs of the girders to prevent lateral shifting of the track. The ties are prevented from creeping by hooked bolts attached at intervals to the top angles of the girders. There is one track of 30-in. gage on each box girder.

Table 1 gives the cost of the various items connected with the construction of this trestle.

STEEL VS. WOOD

From figures obtained from several mines it has been found that in 5 yr. the total cost of repairs and renewals on wooden stocking trestles amounts to the original cost of the trestle. Breakage in legs is exceedingly high, often amounting to as much as 33 per cent per year. If for any reason ore is not shipped and the legs are allowed to remain in the pile for several seasons it has been observed that they rot rapidly. Weather conditions have considerable to do with the percentage of broken legs. If ore is dumped on a frozen face of the stock-pile and this new ore freezes rapidly, it will often move in a mass down on the frozen face and break the legs. Large masses of frozen ore also shift in this way during loading with the steam shovel.

The cost for erecting and dismantling was kept at two large mines for a period of years. It was found to amount to \$1.20 per foot. Under unusual conditions this has

run as high as \$1.60 per foot. The portion of the trestle between the shaft and the point where ore is stocked is usually called the permanent trestle, the other part being the stocking trestle. The permanent trestle is put up in a very substantial way and is expensive, costing as much as \$15 per foot. After a period of 10 yr. this permanent trestle is sure to be in bad condition. A few of the stringers not directly below the tracks will probably last for a short additional time, but for the sake of an estimate it can be assumed that the permanent trestle will have to be entirely rebuilt in 10 yr.

In making the comparative statement of the cost of wood and steel shown in Table 2 the expenditure each year at 6 per cent compound interest has been used. This yearly expenditure has been accumulated and figured at compound interest for a period of 20 yr. It is found that at 6½ yr. the costs for wooden and steel trestles of the same length are practically the same. As the time increases the accumulated amount for repairs, renewals, erecting and dismantling increases very rapidly. At the end of 20 yr. the saving in favor of the steel trestle is \$117,000. It is impossible to estimate the saving due to better tracks and operating conditions and consequently the minimizing of delays on the surface. With a wooden trestle a certain number of carpenters and extra laborers must be employed. Only a part of their time can be charged against the stocking trestle, but it is nevertheless necessary to have them available when repairs are needed. At the Negaunee mine there is one carpenter, whose entire time is spent in the shop.

In 1909, when it was found necessary to sink a new shaft, Stuart R. Elliott, local superintendent at the Negaunee mine of the Cleveland-Clipp Iron Company, began to collect data as to the comparative cost of wood and steel trestles. Several sketches of steel trestles were made and submitted to J. F. Jackson, vice-president of the Wisconsin Bridge & Iron Company, at Milwaukee. After preliminary sketches and shop estimates had been made the bridge company was asked to make final drawings and submit its bid, which was accepted, and the trestle described was constructed.

Rapid Gate-Closing Device
Mounted on Motor Truck

Apparatus Used by Boston Water Department
Does in 10 Minutes Work Which Formerly
Took Four Men 45 Minutes

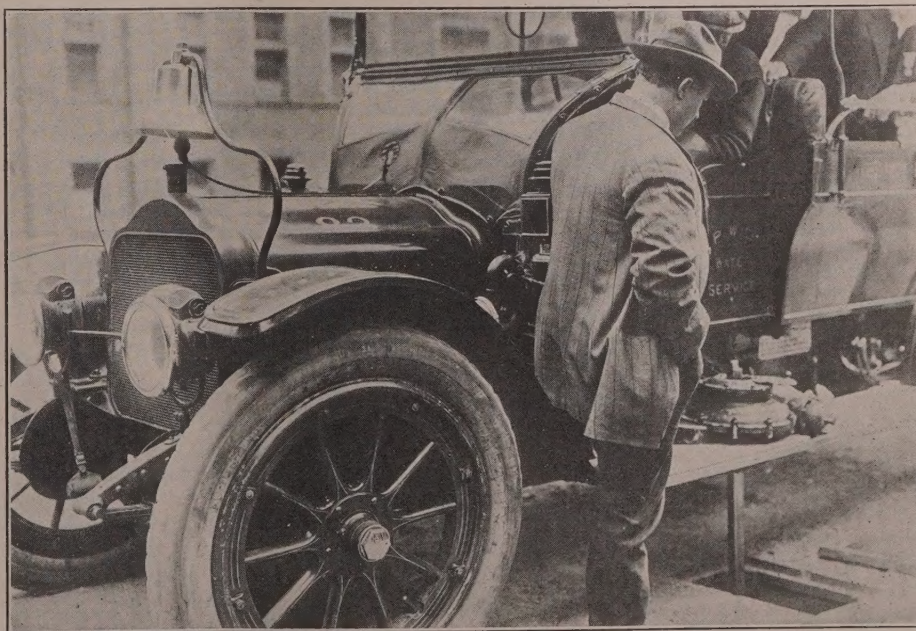
A GATE-CLOSING device, consisting of a universal wrench socket with a worm gear inclosed in an aluminum housing and mounted on the running board of a White motor truck so that it can be easily and quickly brought into position over a water gate manhole, is used by the Boston Water Department. It is the invention of George H. Finneran, superintendent of the distribution branch, and is claimed to do in 10 min. work which formerly required four men, laboring 45 min. The truck is required to respond to fire alarms and other emergencies where water must be controlled to prevent loss or damage.

When the truck is in position a wrench is slipped through the socket. This wrench fits the nut on the gate-gear below. The universal wrench socket, together with a universal joint on the end of the wrench, affords sufficient flexibility in case the truck is not on level ground or in case the wrench socket is not directly over the gate nut. It is an easy matter, however, for the driver to bring his truck into the exact position.

APPLICATION OF POWER

The worm gear is driven from the regular transmission of the truck. The device is operated by a lever placed upon the side of the truck and easily accessible to the driver. In closing gates the forward speeds of the transmission are used. In opening the reverse is used. All gears are made of chrome or nickel steel. All bearings are ball bearings. The aluminum housing is firmly bolted to the frame of the chassis and well braced to resist torque. The wrench is a hollow square steel tube terminating in a specially hardened steel socket with universal joint between socket and tube.

Most of the gates are equipped with indicators showing the position of the valve and informing the operator when the valve is seated or entirely opened. Where indicators have not been attached to the gates,



GATE-OPENING DEVICE ON MOTOR TRUCK FOR BOSTON WATER DEPARTMENT

TABLE 2—COMPARATIVE COST OF WOOD AND STEEL STOCKING TRETTLES

	6½ yr.	20 yr.
Permanent wood trestle.		
Original cost, 500 ft. at \$15.	\$7,500.00	\$7,500.00
Repairs and renewals, 10 per cent per year.	4,875.00	15,000.00
Six per cent compound int.	4,692.29	30,798.02
Total.	\$17,067.29	\$53,298.02
Temporary wood trestles.		
Original cost, 2094 ft. at \$6.	\$12,564.00	\$12,564.00
Repairs and renewals, 20 per cent per year.	16,333.20	50,256.00
Erecting and dismantling, \$1.20 per ft. per year.	16,333.20	50,256.00
Six per cent compound int.	14,063.33	122,822.09
Total.	\$59,293.73	\$235,898.09
Total cost wooden trestles.	\$76,361.02	\$289,196.11
2594-ft. steel trestle.		
Original cost.	\$51,228.92	\$51,228.92
Estimated maintenance cost.	1,300.00	4,000.00
Six per cent compound int.	23,949.51	116,867.78
Total.	\$76,478.43	\$172,096.70
Net saving.	117.41	117,099.41

a counter is used. This counter is placed on the end of the wrench recording the number of its revolutions. This helps the operator to determine when the valve is entirely up or down. As a means of safety in the event of the valve seating with force or before the operator expected, a pin of known strength, placed in the universal joint of the wrench, breaks off and breaks the line of force between the engine and the gate, thus preventing damage to either the gate or the gate-operating device.

Rail-End Connections for Drawbridges

Reasons Advanced by A. J. Himes to Show Why Loose-Mitered Rails for Swing Spans, However Safeguarded, Should Be Condemned

RAIL-END connections for drawbridges, it will be recalled, were the subject of spirited discussion at the convention of the American Railway Engineering Association last March, and in the end the recommendations of the committee on iron and steel structures were withdrawn, to be considered next year. The committee had recommended that rail ends should be cut square and connected by sliding sleeve or joint bars, or by easer rails. No mention had been made of the mitered rails used by a number of prominent roads, and the recognition of such mitered connections as good practice was the bone of contention in the discussion. It developed that while the committee did object to some extent to all-mitered joints, the real objection was to the mitered connection for swing spans, where on account of the lap of the rails one pair of rails must be loose so as to pass over the other pair in opening and closing the bridge.

In the August "Bulletin" of the association A. J. Himes, valuation engineer of the New York, Chicago & St. Louis Railroad, and chairman of the committee mentioned, discusses the subject further, describing a successful installation of the square-end type, and giving reasons why in his estimation joints requiring loose-mitered rails, however safeguarded, should be condemned. These notes are taken from his discussion.

A SUCCESSFUL INSTALLATION

An installation of the type recommended by the committee is in service on the New York, Chicago & St. Louis Railroad bridge over the Black River at Lorain, Ohio. It was constructed in 1904 and has been in service ever since. The average number of openings of the bridge during the summer is 250 per month. The service is entirely satisfactory. Neither the cost of construction nor the operation of the device was ever looked upon as unduly burdensome. No accidents have resulted from its use.

The rails are full spiked up to the ends of the bridge. The rails are cut square. The rail lock envelops the rail and moves back and forth as it is necessary to open or close the bridge. The lock is operated from the power house on the bridge, where an indicator geared to the machinery shows at all times its position. The desired condition is that the bridge operator shall know positively when the rails are in position for traffic. For this purpose, all movements of the machinery are interlocked so as to follow each other in predetermined order and the signals cannot

clear the bridge until the lock is driven home.

It is to be noted, however, that if, in some unforeseen manner, a train should approach the bridge against the signals and the bridge was ready for service, except that the rail locks were not closed, then the only danger would be that arising from an opening of 1 or 2 in. between square ends of rails held rigidly in position. The condition would be like a rail crossing except that the width of the open space would be variable, either more or less than the throat of the crossing. Derailment in such a case is not likely to happen.

OBJECTIONS TO SQUARE ENDS ANSWERED

The objections raised to this form of joint by those who have not been successful in its operation are: (1) That it is difficult to center the bridge so precisely that the rail will enter the sleeve when the lock is being driven; (2) that the flowing of the metal in the rail head under traffic will cause the rail to bind in the lock when closing, and (3) that the joint rides hard.

The first objection can exist only where the devices for centering the bridge when closed are so imperfect as to be a menace to the safe operation of any kind of rail-end connection. Imperfect centering devices have been excuses for the use of imperfect rail-end connections. The centering device used on the above-mentioned bridge consists of a bed casting, secured to the masonry, and containing a step or socket with sloping sides into which enters a vertical plunger attached to the bridge. This plunger is designed primarily to lift the ends of the bridge after closing, so as to take out the droop and cause the stresses in the trusses to act properly under load. The plungers also form the principal supports of the trusses at the ends of the bridge. When these plungers, with their beveled faces parallel to the track, enter the sockets on the masonry with their sloping sides, the bridge is drawn back precisely to its original alignment and held rigidly in position. The rail locks can then be driven without difficulty.

The second objection, that flowing metal will cause the rail to bind in the locks, simply means that the lip formed by the flow on the corner of the rail must be trimmed with a chisel before it begins to bind in the locks. The metal flows so slowly that such a task is not at all difficult, and faithful attention is a perfect remedy.

The third objection is that the joint rides hard. This is real, but it is a matter of degree. Rail crossings ride hard. Where traffic is heavy and rails wear out, the natural expectation is that a portion of the income will be used to replace the worn-out parts. If the joint is well maintained, the riding of the trains will give little concern to the most fastidious.

It is, of course, easy to see that if mitered rails are used on a swing bridge, the rails must be lifted to permit the bridge to swing. The device, though wrong in principle, has been developed and perfected to such a degree that under the most perfect conditions it should not be called unsafe. Yet for one who still clings to its use the most convincing argument against it is to stand on the end of a bridge about four feet from the rails during the passage of a fast train. A man's reason may tell him that loose rails are safe, but in such a position his in-

stinct will prompt him to seek safety in flight.

Logically there are two special objections to loose and mitered rails. It frequently happens, in their operation, that when an attempt is made to lower the rail to position it will lodge on top of the shore rail and remain there. Some very perfect signaling devices have been designed to give warning of such a failure, but it is a fact that if the rails were not mitered, the emergency would not arise and no warning would be needed. In other words, there is introduced an extra function of signaling to save the mitered rail.

It is generally supposed that the draw-bridge disaster at Atlantic City in 1906 was caused by a loose-mitered rail. The disaster at Sandusky Bay in 1896 had a similar cause. It may be that under perfect conditions no accident will happen to a loose-mitered rail. Certainly no accident will happen if there is no such rail.

Numerous rail breakages in recent years have led us to inquire what might happen if one of these loose rails should break under a train. It might not cause a derailment, but the danger would be very great. To guard against such a contingency straps of steel are sometimes bolted to the web of the rail. Such protection is undoubtedly good if the loose rail must be used.

Original Cost to Date

Accounting Committee of Railroads Thinks It Is Not Obtainable for Each Piece of Property, but Valuable in Special Cases

A RESOLUTION adopted recently by the accounting committee of the Presidents' Conference Committee and transmitted to the director of valuation of the Interstate Commerce Commission reads as follows:

"Resolved, That the chairman be and hereby is instructed to submit to the Presidents' Conference Committee a summary by roads of the replies of the carriers to the circular of Sept. 5, with the comment that these replies prove conclusively that through various causes, such as the absence of authoritative classifications of property accounts prior to 1907, destruction of records by fire, or otherwise; reorganization, purchase, merger or consolidation, without the acquisition by existing carriers of the records of former companies, etc., 'original cost to date' cannot be ascertained 'in detail as to each piece of property,' nor can existing records be completely analyzed to show division by primary accounts, nor by sections or road or structures.

"The committee is, however, of the opinion that much valuable information as to the accounting cost of individual structures or other pieces of work, especially of recent date, can be ascertained by the Government from the accounts of the carriers, although the actual cost may be understated because of the absence of overhead and similar charges.

"Practically the same conditions will affect the accuracy of any analysis of cost of properties or betterments not charged to road and equipment account.

"For the above reasons, this committee is of the opinion that the orders suggested by the director of valuation would not produce results sufficiently complete to justify the labor and expense of preparing a partial analysis, and should not, therefore, be issued."